DIGITEL High Volume Aerosol Sampler

DH77 in field housing

Manual

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DIGITEL enviro-sense

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3 Introduction

This user manual contains complete information concerning operation, assembly and putting Digitel High Volume Samplers DH77 under operation.
Read safety instructions carefully before putting the instrument under operation.

3.1 Safety instructions

Adhere to the following safety instructions, assembly instructions (Chapter 3.3) and maintenance instruction (Chapter 3.5). Failure to adhere to these instructions or improper installation and instrument operation may imperil your safety or result in damage of the instrument and neighbouring equipment.
The dust particle sampler electric connection should be performed according to provisions of DIN VDE 0100 and its applicable special provisions. In particular, the principles should be followed as listed below:
-box earthing;
-preparation of protective insulated, waterproof power supply;
-equipment of the mains connection with FI switch with I(DN) <= 30 mA.
In case of lack of expertise, the installation is required to proceed by a professional electrician.
In order to ensure protection for over-voltage due to atmospheric discharge, follow DIN VDE 0100 part 443. If the field instrument is connected to a remote measurement booth via a communication line, e.g. for status inquiries or for remote control, the communication line shielding and earthing of the line shield has to be abided.
-When using roof bushings, the steps have to be followed as listed below: set up an electric connection to the air-sampling inlet tube from the roof bushing earthing terminal, in order to lead away possible atmospheric discharges.
-If not, discharges can occur via a wind mast, as well as lightning hit into the container power supply overhead lines. For protection, there should be considered a lightning arrester or a protective shielding according to DIN VDE 0100 section 18 or part 443.
-Before assembly or disassembly of the instrument's components, the instrument should be permanently isolated from the power supply.
-Prevent penetration of liquids into the instrument.
-Please observe keeping the prescribed power supply voltage value.
-Observe correct fusing (10 A) of the power supply. Before switching the instrument on, make sure all connectors are plugged in a correct manner.
-Except for interventions explicitly provided in the manual, never try to repair the instrument on your own. Otherwise, you are exposed to get into contact with parts under the mains voltage. All repairs may only be carried out by expert staff.
-Only genuine Digitel inlets are allowed to be connected to the connector for inlet heating. Upon applying unauthorised inlets, burns may occur upon touching an inlet due to its overheating.
-Replacement of defective fuses in the instrument can be carried out only by trained experts. Only fuse types authorised by Digitel are allowed to be applied (information directly from Digitel or call a competent local branch-office).
-The instrument should be isolated from the mains and handed over to a service engineer in following cases:
  -if a mains cable or a plug is worn or damaged;
  -if the instrument, despite following the stated operation instructions, does not work properly. Only use those controls referred to in the manual, as improper instrument operation may cause damages;
-if the instrument fell down or the case is damaged;
  -if the instrument shows conspicuous deviations from normal operation.
  -Ensure the instrument to be permanently closed during unattended sampling period.
  -If you need any assistance, please do not hesitate to contact us. We would be pleased to advise you.

3.2 Proper use

-The instrument is designed for industrial use.
-The instrument is manufactured in compliance with applicable state-of-the-art and safety/technical standards. Nevertheless, the use of the instrument can still endanger the instrument itself or other valuable things.
-The instrument meets the EMC requirements (electromagnetic compatibility) directives and harmonised European standards. Any variation of the system may affect EMC behaviour.
It is an A-class equipment. This equipment may induce high-frequency interference in a residential area. In this case, the operator must take appropriate measures.

3.3 Target group

-All designing, programming, installing works, initiation, operation and maintenance in relation to the sampling system must only be carried out by trained staff (e.g. electricians, electrical engineers).
-Designing and programming staff must be familiar with safety concepts of automation technology.
-Operators have to be instructed on handling the instrument and know the operation instructions.
-The staff in charge of installation, initiation and maintenance should have professional background to be authorised to intervene in automation systems.

3.4 Abbreviations

CM	Correction factor for air flow through the filter (related to an average air pressure and an average air temperature in the measurement tube during the sampling period)
Cs	Correction factor for air flow on the measurement tube related to the set standard conditions (standard air pressure and standard air temperature)
CA	Correction factor for air flow on an inlet (related to an average air pressure before and after sampling and to an average temperature on the measurement tube - 3 K during sampling period. Calculation of this correction factor is based on simplified assumptions, whereby smaller deviations from the actual correction factor on the air inlet can occur
VM	Air volume transported through the filter during the sampling period (related to an average air pressure and to the average air temperature in the measurement tube during the sampling period)
Vs	Air volume transported through the filter during the sampling period (related to the set standard conditions)
VA	Air volume transported through the inlet during the sampling period (related to the average air pressure before and after sampling and to the average air temperature in the measurement tube - 3 K during the sampling period of time. Calculation of this volume is based on a simplified assumption, whereby small deviations from the current transported volume can occur at the air inlet
p (uncal)	Non-calibrated air pressure measured by the measurement system
pM	Actual air pressure in the measurement system
paM	Average air pressure in the measurement system during the sampling period
ps	Standard air pressure (the air pressure to which output of values for cs and Vs have to be related)
TM	Current air temperature on the measurement

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	system
TaM	Average air temperature in the measurement system during the sampling period
Ts	Standard air temperature (the air temperature to which output of values for cs and Vs have to be related)
PA	Current air pressure at the air inlet (operation pressure)
PaA	Average air pressure at the air inlet during the sampling period (average operating pressure)
TA	Current temperature at the air inlet (operation temperature)
TaA	Average temperature at the air inlet during the sampling period (average operation temperature)
p/T	Air pressure/temperature
HVS	High Volume Sampler

3.5 Typographic conventions

Text parts in `Courier New` without a framework show a thermo-printer, a serial interface or USB output
Example:

```
Fr 05.09.03    11:02:47
Work
```

3.6 Contact consulting

In case of any questions concerning the Digitel High Volume sampler DH77 please contact the responsible of the Digitel representation office or apply directly to one of Digitel branch-offices. Postal addresses, phone and fax numbers as well as e-mail are shown on the cover page.

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4 System description

The Digitel High Volume sampler DH-77 is a part of the systems to sample dust and aerosol particles for later assessment and analysis. The sampler operation range in standard execution is 100 to 1000 litres per minute (6 to 60 cubic metres per hour).
The system is usually called „High Volume Sampler“.
Various models of samplers are available from different applications. Generally, they differ by the number of processing filter, by the type of logging failure indications and status messages as well as by the type of remote control via various interface protocols.
A survey of available models is shown in the chart of chapter 12.
Airborne-dust parts in the sampled air are separated onto 150 mm diameter filters. The flown filter diameter is 140 mm.
Sequent gravimetric and analytical analysis could be conducted depending upon the pollutants of interest. Filter material and structure selection (deep filters, porous filters, glass fibres, silica fibres, pulp, Teflon, porosity....) will depend on the analysis purpose. The filter conditioning is important in order to achieve reproducible results. The DH-77 is a single filter device.
A rotameter controls the selected air flow rate. This value should be calibrated at the beginning of a measurement session first, using a gasmeter or a secondary standard, e.g. an additional rotameter. During air sampling, the pump flow rate is dynamically controlled, so that this value is kept at good reproducibility and at a long-term stability despite the deposited filter flow resistance and the sampled ambient air pressure/temperature variation.
An integrated microprocessor unit controls the filter changes at the exact preset time and collects all relevant data and events. Hereby the air quantity flowing through the filter is defined with high accuracy.
All mechanical components of the changing automatics, as well as the units needed for measurement as sampling probe, pipeline, flow chamber and filter holder, have been improved: they are coated with highly corrosion-resistant and extremely smooth „Ematal“.
For total suspended particulates (TSP) sampling, there are two differently designed sampling probes available:
- a cylinder probe (EMPA/UBA probe); and
- a probe of „open ring slot“ according to VDI as described in GMBI 1983 regarding non-fractionated dust sampling.

Sampling probes PM10/PM2.5 are designed as single-stage impactors. They are intended for operational/volume flow of 30 cubic metres per hour.
Sampling probes PM1 are designed as double-stage impactors. They are designed for operational volume flow of 22.1 cubic metres per hour.
Various remote-control interfaces are built in for operation in automated measurement networks.
The High Volume sampler DH-77 is described in the VDI directive No. VDI 2463, sheet 11.

4.1.1 Connections

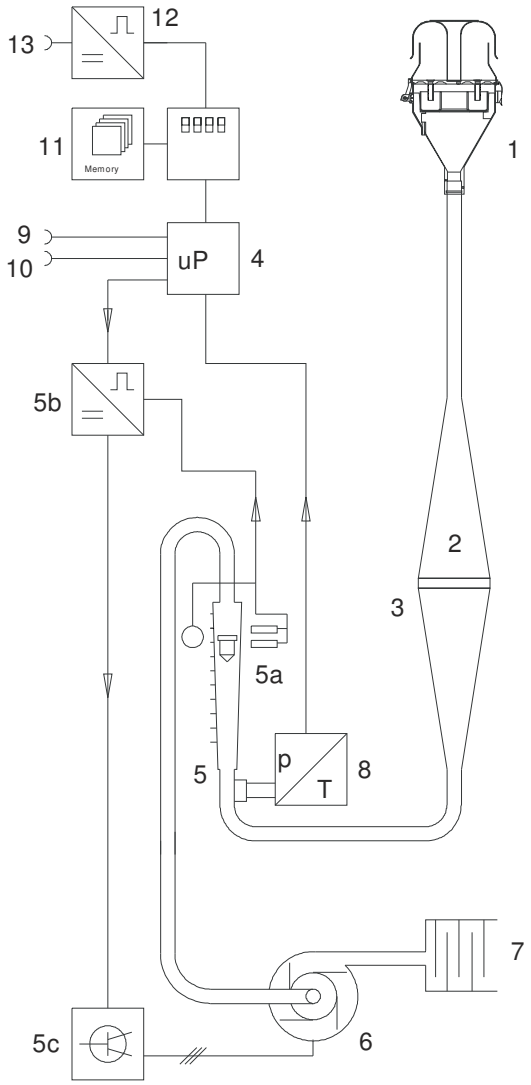
4.1.1.1 DH-77

In addition to the power-supply connector (3-pole instrument plug according to IEC 320), the standard execution of DH-77 has a connection option for a serial interface (RS-232 C). The connector is placed in the compartment of the filter container at the side. For pin allocation see 9.1 „Pin allocation of D-Sub-9 (terminal interface)“.
Connection to a PC can be made via a commercially available zero-mode cable (crossed cable). For cable lengths and installation requirements, please, adhere to the general specifications RS-232C.

4.1 System overview

4.2 Operating mode

The below-stated figure No. 1 illustrates the mode of operation.



1	Pre-separator
2	Separator chamber
3	Current filter
3a	Filter stock
3b	used filter
3c	Exchange electronics
4	Microprocessor control
5	Flow meter
5a	Flow sensor
5b	Flow control
5c	Frequency converter
6	Blower
7	Noice damper
8	Pressure & Temperature measurement unit
9	Printer interface
10	RS-232C Interface
11	PC-Card interface
12	Wind data converter
13	Wind data interface

The air is sampled via a sampling probe (1), using a sampling tube, vertically from the top to the bottom through the filter (3)

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placed in the flowing chamber (2). After the filter, the transported air quantity is measured using a rotameter with a floater (5). Its double photo-sensor (5a) optically senses the floater position. In connection with the control electronics (5b, 5c), the capacity of the pump (6) is adapted to the rpm control, so that the air quantity keeps the set-point value.
Air pressure and temperature are measured upstream the flow meter and continuously averaged by the controller. A real-time protocol states sampling volumes yielding from the sampling time and controlled volume flow as the core information. The air is released from the instrument with reduced noise through noise baffle (7).

4.3 Assembly

4.3.1 Transport

In general, the instrument should be transported in vertical position.
Digitel DH77 is provided with two handles (sunk on each side of the case) and two rollers. The instrument can be slipped or pulled by tilting it slightly backwards on a smooth compacted ground (e.g. asphalt, concrete) on the rollers using the grips.
Unless rolling is possible using the integrated rollers, the instrument can be lifted and carried using both the handles.

The instrument must not be lifted by using the open instrument door as a handle.

4.3.2 Field installation

Digitel DH77 is equipped with a protection class IP54 field case. For this reason it is immediately suitable for direct open-air installation under European standard weather conditions.
To avoid collection of rainwater or ice on the instrument front door upper edge, a rain drip rail (optional) should be installed.
In the field, the instrument should be placed in such a way that penetration of surface water in case of heavy rain or snow melting into the instrument from the ground upwards is prevented.
The sampler has to be secured against tilting. In mobile applications, an extension of sufficient stiffness of one metre long instrument-feet is advisable. For this purpose, e.g. two rectangular tubes can be screwed on the short feet of the instrument.

If stationary operation is planned, the sampler should be installed higher on a concry base (e.g. width = 600 mm x depth = 300 mm). The door opening should not face the weather side and the sampler feet should be screwed using two angle sections with a base.
If sampling is discontinued for a long term during winter operation, a case heater (optional) should be installed to prevent icing of the automatics.

Digitel High Volume Samplers should be connected to the mains of 1 x 230 V/50 Hz (at least 3 x 1.0 mm2, 10 A, 250 V). The maximum input current is 7 A without a probe heater (max. 160 W) and case heater (approx. 60 W). The increased input power at running up the blower is avoided by a soft run-up. For electric connection of the aerosol sampler see 3.1 "Safety instructions".

WARNING
In any case, the instrument should be installed or built in, in such a way that the instrument can be continuously disconnected from the mains easily by pulling out the supply cable at any time. The main switch on the front wall does not assure complete instrument electrical isolation!

4.4 Consumables

4.4.1 Filter paper

Round filter of 150 mm diameter
Selection of filter material and filter structure (deep filters, porous filters, glass fibres, quartz fibres, pulp, Teflon, porosity...) depends on the aim of examination.

4.4.2 Thermo-printer paper

Thermo-rolls size: 57 x 25 x 10 mm

4.4.3 Sealing rings

Sealing rings with a special finish and various sizes are used for sealing at various places in the instrument. If the instrument‘s tightness is not satisfactory any more or the surface of sealing rings shows small cracks or other damages, they should be replaced. Sealing ring sets can be ordered from Digitel.

4.4.4 Fuses

WARNING:
Fuse replacement can only be performed by an authorised specialist. Before opening the instrument, it should be off power. Further, it is necessary to assure that only the fuse types authorised by Digitel are used. In case of necessity, please, contact Digitel or a responsible local representation branch-office directly.
In the supply unit, two fuses can be replaced:
Main heating: Schurter type FSD 5 x 20; 1.2 AT, rated voltage 250 V;
Controller supply unit: Schurter type FSD 5 x 20; 100 mAT, rated voltage 250 V;

4.4.5 Mains cable

WARNING:
Only use mains cable supplied by our company or an equivalent mains or extension cable complying with applicable standards. When using the rolled extension cable, make sure that the cable is completely unwound from the cable reel. Mind: cable reels without a thermo-fuse have a risk of fire because of strong heating of the wound-up cable!
Use a Euro-instrument cable with SCHUKO-plug at least 3 x 1.0 mm², 10 A only.

4.4.6 Grease for sampling heads (impactors)

Examples for greases that can be used: BAYSILON paste, high-vacuum grease, medium-viscous (35 g tube) and silicon high-vacuum grease medium Merck 100 g,
CAS Nb. 107922.

4.5 Maintenance

Digitel High Volume Samplers need minimum maintenance. However, depending on the degree of air pollution and climatic load upon installation site, inspection of the sampler associated with cleaning is necessary.
In particular, the following activities shall be performed:

4.5.1 Cleaning

High-volume samplers must be cleaned on regular basis. Cleaning intervals strongly depend on particulars of installation site and they have to be determined by the operator. They may range from one month up to a year.

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During cleaning, the instrument should be off power.
To clean the instrument, a dry cloth should be used. At heavy contamination, the cloth should be wetted with a commercial window cleaning agent. Make sure that the instrument is dried up before putting under operation again.
Avoid using solving and scrubbing cleaning products!

The flow meter glass tube has to be visually inspected. In case of a broken filter or negligent sampler operation without a filter inserted, contamination can also occur. In case of any doubt, the tube has to be removed and cleaned.
Due to its difficult accessibility, the upper part of the funnel-shaped flow chamber located before the filter, can only be cleaned in combination with possible changer apparatus service works. As this section of air-sample path shows a much larger inner diameter, as a rule, it is less affected by deposits.
The air inlet tube interior has to be inspected for wall deposits and in case of doubt, cleaned, using a cloth. As a cleaning liquid, we recommend water and/or spirits.
TSP sampling probes ("open ring-slot" according to VDE or "EMPA/UBA" - cylindrical probes) have to be checked for dust deposits and cleaned, if possible. Normally cleaning with the use of a wet cloth is sufficient. Probes PM10, PM 2.5 and PM1
To avoid effects of released separated rough dust particles, the cannon surface of the impactor plate has to be permanently covered with a thin fat layer. It has to be renewed periodically. Thereby the life cycle depends upon the proportion of rough dust in the sampled exterior air. It is recommended to clean the impactor plate after 14 sampling days, by the time the average total dust volume (TSP) on the installation side is approx. 70 to 80 µg/m³. With lower TSP, the cleaning interval can be longer.
The cleaning interval can be reduced by rotating of the moveable impactor plate resting on the heating holder by about 15° (approx. 2 cm). Acceleration nozzles then point at the "clean" areas between rough dust deposit settled in a circular form of the previous sampling operation.
The impactor plate can be removed simply after opening the probe upper part. It has to be cleaned with a clean cloth and its cannon surface has to be greased. A 5 cm long band of grease should be equally spread on the area, using a spatula. To relieve this maintenance in the field, the impactor plate can be replaced by another plate prepared in the laboratory.
Acceleration nozzles, probe casing liners, as well as liner behind the impactor plate with the above-mentioned TSP condition have to be cleaned after 30 flowing days.
In case of longer sampling in foggy environment it is recommendable to inspect the impactor plate for water condensate.

4.5.2 Exchange of sealing rings

The transition areas between the above-stated path separate section of the air probes are equipped with sealing rings.
Special attention has to be paid to the sealing ring of 43 x 3 mm at the sampler air inlet muffle, as well as to the glass measurement tube's sealing rings (50.4 x 3.53 mm). These sealing rings have to be checked and possibly replaced after 2 to 3 years of operation.
The sealing ring of 150 x 3 mm at the bottom flange of upper part of the flowing chamber should be inspected by a Digitel service engineer and possibly replaced after 2 to 3 years of operation.
Sealing rings (150 x 3 mm) at the filter holder bottom part have to be equipped with an anti-friction layer. They have to be regularly checked when a new filter is inserted and rubbed, using a dry cloth. When this layer is worn out or in case of increasing sticking tendency, it should be renewed. We recommend to replace these sealing rings annually.

4.5.3 Tightness test

Checking of volume-flow calibration
Blower charge and the required convertor frequency indicated for a particular flow rate and filter type have to be noted at the beginning of instrument operation. Sudden insufficient blower capacity under the same conditions is caused by leakage in the air-sample path (after the filter).
Another very simple option for testing the sampler tightness consists in closing the sampler at the air inlet muffle with air inlet tube removed or, as the case may be, by inserting an air-impenetrable cardboard instead of the filter paper to the filter holder and switching the blower on. In both cases, the flow meter floater must not be lifted from its resting position at the bottom of the measurement tube. Hereby the blower must be run up to its maximum capacity in order to reach the overload condition.
Checking of the volume flow simultaneously represents a check of tightness. These procedures have to be taken about every two months.
The second flow meter of the same type as in the sampler used to check the volume flow in the sampler itself and has to be installed onto the sampler sampling probe as "transfer standard". With a new round filter paper inserted, positions of floaters are compared by switching the blower on. With deviations of the set point originally calibrated on the flow meter of the sampler, checking of tightness should be performed.
There are specified flow meters with calibrated glass tubes available at Digitel (calibration unit).

4.5.4 Visual inspection of homogeneous deposit

Upon removing dusty filter papers or during weighing, filters have to be subject to visual inspection for homogeneous deposits. Drop-like spots in the filter centre, as a rule, indicate inoperable probe heating, or/and a defective air inlet muffle sealing ring. Bright spots on the filter paper rim are attributable to defective sealing of the flowing chamber upper part with the filter holder upper surface (service works are definitely required!).

4.5.5 Acoustic inspection of blower

The applied blower has the average MTBF (average time between failures) of 36 000 hours. It is maintenance-free. However, for instruments under operation for longer than two years, an occasional acoustic inspection of the blower by an open room blower is recommended to prevent a possible blower blocking.
Special attention has to be paid to excessive, unusual noises generated by the blower (scrubbing, screeching).

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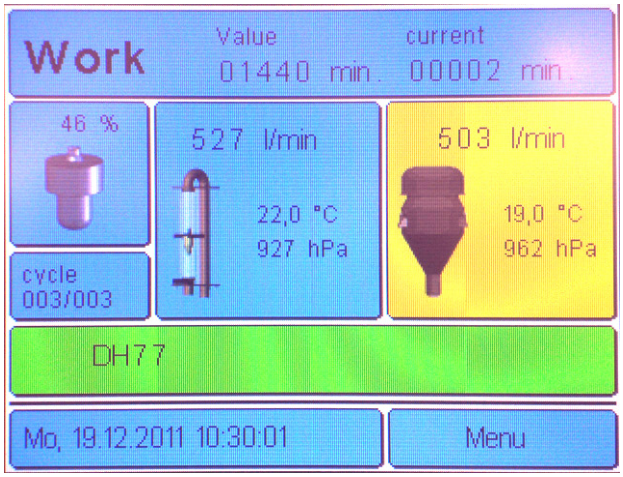
5 Controls

Controls are ordered in a sequence according to their functional relevance on the front panel.

5.1 Touchscreen

The operation of the DH77 will be carried out via the touchscreen.
The status of the program as well as all status and error messages/notifications will be displayed.



The navigation at the touchscreen is just a question of touching the particular zones. All pale blue operation zones are zones with a function. By touching the pale blue zones they will turn into dark blue.
In case of errors resp. malfunctions, the corresponding operation zones will be displayed in red. These red operation zones can be activated as well. By touching them they will turn into dark blue.

5.2 Main Switch

The device is switched off via the main switch

5.3 Status LEDs

Supply on
The status display lights up as soon as the main switch is set on "on" (resp. "1") and there is no error at the power supply.

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6 Function Description

6.1 Status Messages

Please read the following text for description concerning the status messages which may appear during HVS control and how they are displayed and logged. The logging (showed below) corresponds to the logging made by an optionally connectable printer. If no special protocol is programmed for the RS-232C interface, in addition to that, the log data will be put out parallel in the same format on the RS-232C interface.
The type of logging of the various special protocols can be found in the annex of this manual.

6.1.1 Remote control

If the remote control (analogue remote control via remote control connector or remote control via serial interface) is activated, it is logged as follows:

```
Fr 05.09.03     11:05:28
extern
```

The status message is deleted as soon as remote control is deactivated.

6.2 Failure indication messages

The following is a description concerning the HVS control failures and how are they displayed and logged. The messages provided in the following protocols correspond to those of the optionally connectable printer. If there is no special protocol programmed for the RS-232C interface, in addition to that, the log data will be put out parallel in the same format on the RS-232C interface.
The type of logging in various special protocols can be found in the annex of this manual.

6.2.1 AC Power supply failure

After a power breakdown, the start and the end of the power supply is displayed as follows:

```
Power cut from :
Fr 05.09.03      10:56:23
until :
Fr 05.09.03      11:02:45
```

If invalid characters (special characters) occur in the date or in the time, or the date resp. the time indicates an invalid value, it suggests that the back-up battery is empty. By a power supply breakdown, the clock module cannot preserve its data! In this case, the back-up battery should be recharged (switch HVS on for several hours) or check the battery and the controller for damages.
After the display of the time of breakdown, the actual status of control will be displayed (working, pause...):

```
Fr 05.09.03     11:02:47
Work
```

6.2.2 Overloading

If a blower overload status is detected, the blower is automatically switched off and the overload message is displayed:

```
Fr 05.09.03     11:04:12
Overload
```

If the program setting also allows an indication of blower load, switching off the blower is also shown on the display:

```
Fr 05.09.03     11:04:15
Blower off
```

In this status, upon the first occurrence of overloading, the control remains for several seconds. Upon next occurrence of the same filter overloading, the status "Blower off" remains for approx. 15 minutes. Then the blower is switched on again.

```
Fr 05.09.03     11:05:28
Blower on
```

There are three successive attempts to insert the filter during the pre-selected working period. After the third occurrence of overloading, the blower will be turned off for 2 hours. Afterwards the blower starts again and a new occurrence of overloading will be handled in the same manner as described above.
The display shows a failure indication message consisting of four lines.
The failure indication message is cancelled, if a new filter is inserted, the program is restarted or a power breakdown occurs.

6.3 Status change

Status changing by the HVS control occurs, if the timer achieves the pre-set value. The logging, showed below, corresponds to the logging of the optionally connectable printer. If there is no special protocol programmed for the RS-232C interface, additionally, the log data will be put out parallel in the same format on the RS-232C interface.
The type of logging can be found in various special protocols in the annex of this manual.

6.3.1 Arbitrary status ⇒ Start time

The HVS control stays in this operation status, until the pre-set start time is reached. Hereby, the start time can be determined for the period of sampling time (if e.g. sampling of daily samples has to be started at midnight). The following logging will be displayed:

```
Fr 05.09.03     11:03:13
Wait
```

The starting point is determined at the menu point "Starting date/time").

In the entry menu for the starting time, it can be selected whether a starting time is to be determined or the program starting is to proceed immediately.

If the control was previously in the working status and the blower was switched on, the automatic switching-off of the blower and the determined values are logged (only if the programming enables so, too):

```
Fr 05.09.03     11:04:15
Blower off

Collecttime[min]: 1012,46
# Blower on/off :    1
paM     [mbar]:   929
TaM      [°C]:   20,0
```


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```
cM       :   1,053
cs( 15/1013)  :   0,949
cA( 17/ 996)  :   0,972
VM     [m³]:  539,268
Vs( 15/1013)[m³]:  492,990
VA( 17/ 996)[m³]:  497,842
at 512 l/min
---------------------------
```

After reaching the starting time, the program is started up automatically. No filter exchange is carried out. The program starts the sampling period using the just inserted filter.

6.3.2 Waiting for starting time ⇒ Work:

When the pre-set starting point is achieved, the HVS control switches the program status to work, switching the blower on:

```
Fr 05.09.03    12:00:03
Work
```

When the programming allows to display the blower status message, the following is displayed within several seconds after the blower running up:

```
Fr 05.09.03    12:00:10
Blower on
```

After approx. 1 minute, the current blower load is displayed (if the program allows it, as well):

```
Fr 05.09.03    12:01:23
Motor load : 65 %
```

If the blower load, during operation, is changed by an adjustable value (in percentage), the current blower load is displayed again

```
Fr 05.09.03    18:04:43
Motor load [%]: 68
```

The blower load display is made by measured values slightly averaged delayed.
When the pre-set working time is reached, the program switch status will turn from work to pause.

6.3.3 Work ⇒ Pause

When the pre-set working time is achieved, the HVS control switches the program status to the pause and the blower will be switched off:

```
Sa 06.09.03    12:00:00
Pause
```

When the programming activates to display the blower status message and time information, the following log is displayed:

```
Sa 06.09.03    12:00:05
Blower off

Collecttime[min]: 1012,46
# Blower on/off :   1
paM    [mbar]:  929
TaM     [°C]:  20,0
cM       :   1,053
cs( 15/1013)  :   0,949
cA( 17/ 996)  :   0,972
VM     [m³]:  539,268
Vs( 15/1013)[m³]:  492,990
VA( 17/ 996)[m³]:  497,842
at 512 l/min
---------------------------
```

Now the HVS control is waiting until the set pause time is reached.

6.3.4 Pause ⇒ Work

When the set pause-period is reached and the program is not completed yet (the programmed running cycles are not reached), the HVS control switches the program condition to work and the blower will be switched on:

```
Sa 06.09.03    12:00:07
Work
```

When the program activates to display the blower status message, the following is displayed within several seconds after blower run-up:

```
Sa 06.09.03    12:00:15
Blower on
```

After approx. 1 minute, the current blower load is displayed (this programming allows it as well):

```
Sa 06.09.03    12:01:23
Motor load [%]: 67
```

In the working status, the basis display shows the related time information.

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7 Operation

7.1 Operation modes

HVS can be operated in two operation modes:
- Autonomous operation: The integrated microprocessor control performs fully automated sampling based on the status times set. Logging is performed on the printer, on the PC USB drive or on the RS232C interface.
- Remote operation: The HVS control is performed via the RS232C interface. Logging is optionally performed on the printer or similarly on the RS232C interface or on the integrated USB drive. In this operation mode, time control is carried out by the host computer. The programmed status times are not considered in the HVS.

7.2 Filter Preparation

Reliable and reproducible measurement results can only be achieved by using filters that are carefully conditioned before and after sampling.
Filters are pre-weighed and provided with a date. In order to enable a checking during the operation by which a correct assignment of filters is possible, the filters are inserted into the filter holder marked according to respective dates. The spring collar is removed from the filter holder (using pliers) while a Teflon ring is laid on a clean surface by using forceps. New filters are removed from the filter magazine by using forceps and laid into the filter holder. Then the Teflon ring should be laid again (using forceps) on the ring and the spring collar is set using pliers. Now the filter holder is ready for transport to the sampler. During the filter transport, no impurities should get onto the filter (therefore refer to standard EN 12341).
The deposited filter is removed from the filter holder, using forceps, and inserted into a simply folded parchment envelope.

Warning! Possible labelling of a filter holder is only permitted on its front, using a marker.
Any inscription on the filter holder on the upper or bottom sides, as well as sticking labels (on the filter holder entire surface) might cause problems with filter exchange and is prohibited!
Please mind that no sealing ring (on the filter holder and in the flowing chamber) gets in touch with inscriptions. The solvents, applied in various markers or pens, destroy the applied sealing rings! Moreover, paint residuals may result in bonding the sealing rings!

7.3 Setting of operation status

7.3.1 Start operation or restart sampling instrument

1. Main switch in the position "On";
2. To perform setting of required status times ("Work", "Pause");
3. To perform settings of required general operation parameters (filter change at overloading, stop time at power breakdown, logging of status and failure indication messages, logging mode);
4. Setting pressure and temperature compensation, selection of values to be logged as well as pressure sensor calibration (required, only if no semi-automated calibration of the instrument has been carried out!);
5. If necessary print applied settings;
6. To insert the filter holder into the flowing chamber;
7. Possible new start time to program and to restart the program or to program flow through the "prestart filter".

So the sampler is programmed and sampling will start at the start time set

7.3.2 Instrument filter exchange and inspection

At the beginning, the instrument has to be inspected more frequently. It is necessary to make the checks as listed below:
- The display has to indicate the time in minutes elapsed since the beginning of the current filter program up to the current time; Mind: always CET!
- The floater of rotameter has to be in its set-point position.

7.4 Flow calibration

7.4.1 General information

In order to measure and to control volume flow, the flow meter accuracy class 2.5 (tolerance +/-2.5 % from the measurement range value) is used with the Digitel High Volume Sampler as a measurement value sensor. To increase accuracy of the transported volume flow, it is possible to perform semi-automated calibration using an external calibrated flow meter as described in chapter 6.3.
It is explicitly pointed out that no marks (e.g. own calibration marks as marker marks, labels...) may be applied on the flowmeter measurement tube. It might result in erroneous functionality or failures that can be hardly detected during calibration!
The values on the glass tube can be considered as rough benchmarks only. In order to be able to determine accurate flow values, it is necessary to determine the floater position in the divisions etched on the measurement tube. Accurate flow in liter/min. can be determined from this floater position, using the calibration table (chapter 12.1).

7.4.2 Calculation

Ratio of flow values of two gases is indirectly proportional to ratio of square roots of their densities.
- the flow meter principle:

$$(1)\quad \frac{Q_2}{Q_1} = \sqrt{\frac{\rho_1}{\rho_2}}$$

Q1: known flow value, reference status
Q2: searched flow value in operation status
ρ_1: known density, reference status
ρ_2: density of measured gas in operation status

Because □ ~ p/T , the operation volume flow gives Q_{loc} (at the place of installed flow meter) from the volume flow value Qscale read from the glass scale as:

$$(2)\quad Q_{loc} = Q_{Scale} \times \sqrt{(p_{ref} \times T_{loc})/(T_{ref} \times p_{loc})}$$

Q_{Scale}: volume flow read on scale
p_{ref}: 1 013 mbar (pressure at which the scale was calibrated)
T_{ref}: 15°C or 288 K (temperature at which the scale was calibrated)
p_{loc}: operation pressure on the flow meter
T_{loc}: temperature on the flow meter

or

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(3) $Q_{Scale} = Q_{loc} \times \sqrt{(T_{ref} \times p_{loc}) / (p_{ref} \times T_{loc})}$

For operation volume flow of 500 l/min under station conditions the following conditions will be on the integrated flowmeter:
$T_{Station\ flowmeter} = T_{Station} + 3K$ (approximate value)
$p_{Station\ flowmeter} = p_{Station} - p_{fall\ at\ filter}$ (will be meassured automatically during calibration)
$p_{Station\ integrated\ flowmeter}$: average air pressure at the installation site minus pressure fall at filter at volume flow of 500 l/min. Which means: the air pressure of measuring system if the air pressure at the inlet is the same pressure as at the station.
$T_{Station\ integrated\ flowmeter}$: average temperature at the installation site plus 3K temperature increase at filter at volume flow of 500 l/min. Which means: the temperature of the measuring system if the temperature at the inlet is the same temperature as at the station.

from the general gas equation $Q_1 \times \frac{p_1}{T_1} = Q_2 \times \frac{p_2}{T_2}$ it follows:

$$Q_{loc\ buil\ -\ in\ flowmeter\ (Station)} =$$

(4) $$Q_{Ref} \times \frac{p_{Station}}{T_{Station}} \times \frac{T_{Station} + 3K}{p_{Station} - p_{fall\ at\ filter}} =$$

$$Q_{Ref} \times \frac{p_{Station} \times T_{Station\ build\ -\ in\ flowmeter}}{T_{Station} \times p_{Station\ build\ -\ in\ flowmeter}}$$

Q_{Ref}: Air inlet volume flow of 500 l/min. under station conditions.
$Q_{loc\ indoor\ Station}$: volume flow in the integrated flowmeter for air inlet volume flow of 500 l/min. under station conditions.
$p_{Station}$: average air pressure at the installation site
$T_{Station}$: average temperature at the installation site

At the station conditions at the integrated flowmeter and from equation (3) and (4) follows:

(5) $$Q_{Scala\ build\ -\ in\ flowmeter} = Q_{Ref} \times \frac{p_{Station}}{T_{Station}} \times \sqrt{\frac{T_{ref} \times T_{Station\ build\ -\ in\ flowmeter}}{p_{ref} \times p_{Station\ build\ -\ in\ flowmeter}}}$$

$Q_{Scala\ integrated\ flowmeter}$: Shown volume flow at integrated flowmeter under station conditions at inlet for air inlet volume flow of 500 l/min. This value is automatically taken over by the control software as a set flow.

At these settings the volume flow at the inlet is Q_{Ref} (500 l/min) if the station conditions are given. The volume flow for different conditions during calibration follows from equation (2) and (5):

(6) $$Q_{Cal\ build\ -\ in\ flowmeter} = Q_{Scala\ build\ -\ in\ flowmeter} \times \sqrt{\frac{p_{ref} \times T_{build\ -\ in\ flowmeter}}{T_{ref} \times p_{build\ -\ in\ flowmeter}}}$$

$Q_{Cal\ integrated\ flowmeter}$: actual set volume flow (actual conditions) at the integrated flowmeter for volume flow of 500 l/min at the inlet under station conditions.
$p_{integrated\ flowmeter}$: actual pressure in the integrated flowmeter during calibration
$T_{integrated\ flowmeter}$: actual temperature in the integrated flowmeter during calibration

or

(7) $$Q_{Cal\ build\ -\ in\ flowmeter} = Q_{Ref} \times \frac{p_{Station}}{T_{Station}} \times \sqrt{\frac{T_{build\ -\ in\ flowmeter} \times T_{Station\ build\ -\ in\ flowmeter}}{p_{build\ -\ in\ flowmeter} \times p_{Station\ build\ -\ in\ flowmeter}}}$$

From the general gas equation and from the equation (7) follows the volume flow on calibrated flowmeter:

(8) $$Q_{Cal\ Ref} = Q_{Ref} \times \frac{p_{Station} \times T_{cal.\ flowmeter}}{T_{Station} \times p_{cal.\ flowmeter}} \times \sqrt{\frac{p_{build\ -\ in\ flowmeter} \times T_{Station\ build\ -\ in\ flowmeter}}{T_{build\ -\ in\ flowmeter} \times p_{Station\ build\ -\ in\ flowmeter}}}$$

$Q_{Cal\ Ref}$: flow on calibrated flowmeter (under actual conditions), so that reaching the operation volume flow of 500 l/min (at the inlet) under station conditions.
$P_{cal.\ flowmeter}$: actual air pressure in the calibrated flowmeter (during calibration is the same pressure at the separator)
$T_{cal.\ flowmeter}$: actual air temperature in the calibrated flowmeter (during calibration is the same temperature at the separator)

From the equation (3) and the equation (8) follows the flow to be set on calibrated flowmeter (under actual conditions), thus reaching the operation volume flow of 500 l/min (at the inlet) under station conditions.

(9) $$Q_{ScaleCalRef} = Q_{Ref} \times \frac{p_{Station}}{T_{Station}} \times \sqrt{\frac{p_{build\ -\ in\ flowmeter} \times T_{Stationbuild\ -\ in\ flowmeter} \times T_{cal.flowmeter} \times T_{ref}}{T_{build\ -\ in\ flowmeter} \times p_{Stationbuild\ -\ in\ flowmeter} \times p_{cal.flowmeter} \times p_{ref}}}$$

$Q_{Scale\ cal\ Ref}$: flow to be set on calibrated flowmeter, so that reaching the operation volume flow of 500 l/min (at the inlet) under station conditions.

7.4.3 Error estimates

A frequent question emerges how errors in temperature or pressure measurements or deviation from assumption applied to the determination of the operation volume affect the calculated standard resp. operation volumes. The order of magnitude of these errors is illustrated below using several examples. Further, there are also stated affects of deviations of actual station conditions during the sampling period how the entered station conditions affect upon calibration of the instrument.

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Accuracy of internal sensors
The pressure measurement in an integrated flowmeter is performed **with** an accuracy of +/-2 % from an indicated value within the entire temperature range of application.
The temperature measurement in the integrated flowmeter is performed with an accuracy of +/-0.75 % from the indicated value in K within the entire temperature range of application.

Flow settings accuracy on calibrated flowmeter
According to the UMEG test report examination in which also the accuracy of the flowmeter flow settings are examined (test of Digitel High Volume Sampler DHA-80 with a PM10 inlet according to EN 12341; the UMEG report No. 6-08/00), the reproducible setting accuracy represents +/-0.45 %.

Flow calculation error due to the sensor error
The following example clarifies the effect of an internal sensor error:

$$Q_N = Q_{Scale} \times \frac{T_N}{p_N} \times \sqrt{(p_{ref} \times p_m)/(T_{ref} \times T_m)}$$

Q_N: average flow on standard conditions
Q_{scale}: the flow set on the flowmeter
p_N: standard pressure (1 013 mbar)
T_N: standard temperature (288 K)
p_{ref}: 1 013 mbar (the pressure at which the scale was calibrated)
T_{ref}: 288 K (the temperature at which the scale was calibrated)
p_m: average pressure on the integrated flowmeter during sampling period
T_m: average temperature on the integrated flowmeter during sampling period

The maximum error of Q_N caused by an error of T_m and p_m measurements is at maximum +/-1.66 % throughout the entire temperature range of application. As a rule, the error is significantly smaller, as the error of pressure measurement at the standard operation temperature range is considerably smaller. Anyway, to this the uncertainty of flow determination of +/-0.45 % has also to be added.
Example:

Q_{Scale} = 520 l/min, p_m = 960 mbar, T_m = 295 K

from which the standard flow is calculated:

Q_N = 500.17 l/min.

if now the measurement of pm transmitted a value higher by 10 mbar (approximately 1.05 % error), it yields an actual standard flow of Q_N = 497.56 l/min. So the standard flow was entered approx. 0.52 % too high.
The result were similar, if the temperature was erroneous: Let us assume the measured temperature was approx. at 2 K (about 0.67 % higher), then it implies actual standard flow of Q_N = 50l.88 l/min. The standard flow was also entered about 0.34 % lower.

Error estimates for calibration
We have based our considerations upon the fact that values required for calibration are given with higher accuracy (current pressure and current temperature on a calibrated flowmeter are better than +/-0.5 %). Assuming that the total error of calibration remains below +/-1 % (+/-0.5 % due to pressure and temperature values and +/-0.45 % due to the accuracy of the setting of the floater in the calibrated flowmeter).

The flow value calculated for controlling depends only upon internal measurement magnitudes of Tm and pm. Herewith, to this value, the above-calculated maximum error of +/-1.66 % applies for this value. Because of the fact that at the moment of calibration the pressure sensor is also automatically calibrated, the error generated by pressure sensor leads in direction of a release limit of the internal analogue/digital convertor. Other considerable error sources (e.g. temperature drift of supply and reference voltages) are not relevant at the present time. Herewith the maximum error is reduced to +/-0.58 %. It should be noted that the uncertainty of flow setting of +/-0.45 % should be added to this value, whereas the maximum total error of automatically calculated flow yields to +/-1.03 %.
The accuracy of pressure and temperature value for station conditions do not result in absolute accuracy of calculated operation and standard volume values! Particularly the average actual operation volumes determined over a year do not correspond to required operation volumes of 500 litres/min., if the average yearly pressure and temperature values do not correspond to the entered station conditions.
Example:
$P_{Station}$: average air pressure at the installation site
$T_{Station}$: average temperature at the installation site
$Q_{Station}$: average operation volume flow at the installation site (500 l/min.)
$P_{Station}$ = 990 mbar, $T_{station}$ = 282 K,
when calibration was performed under these station conditions and the average temperature over a year is deviated by 1 K

upwards, general gas equation $Q_1 \times \frac{p_1}{T_1} = Q_2 \times \frac{p_2}{T_2}$ yields:

$$Q_{Stationnew} = Q_{Station} \times \frac{T_{Stationnew}}{T_{Station}}$$ = 501.77 l/min.

It was transported approx. 0.35 % more in yearly average. This deviation of the required flow, however, impairs the inlet separation degree only to a small extent.

7.4.4 Performing calibration

7.4.4.1 Preliminary notes

Semi-automatic flow calibration only is possible using one of calibrated Digitel flowmeters designed for this purpose. If you wish to relate calibration to an other transfer standard, please contact Digitel directly or a local branch-office in order to get suitable calibration instructions. The same applies to a calibration for an operation volume flow different from 500 l/min.
Calibration for the operation volume flow of 500 l/min. at station conditions (estimated average air pressure and average temperature at the installation site during an expected sampling period) is done with regard to Digitel inlets (PM10; PM2.5) having their "cut point" of 10 µm or 2.5 µm always at this flow rate. At the same time, the comparison of sampling results of as many stations as possible is made simpler.
All calibrated flowmeters delivered by Digitel have a calibration marking (prevailing a red mark) for 500 l/min. at 15°C and 1 013 mbar.

For the performing of forthcoming calculations, the following parameters have to be entered:
- $p_{outdoor}$: current pressure at calibrated flowmeter
- $T_{outdoor}$: current temperature at calibrated flowmeter
- $p_{Station}$: estimated average air pressure at the installation site during expected sampling period
- $T_{Station}$: estimated average temperature at the installation site during expected sampling period;

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- position of the calibration mark on the calibrated flowmeter in mm;
- position of the floater in the calibrated flowmeter before re-calibration;
- position of the floater in the integrated flowmeter after re-calibration.

The following values are automatically determined during calibration:
- p_{indoor}: pressure in the integrated flowmeter during calibration
- T_{indoor}: temperature in the integrated flowmeter during calibration

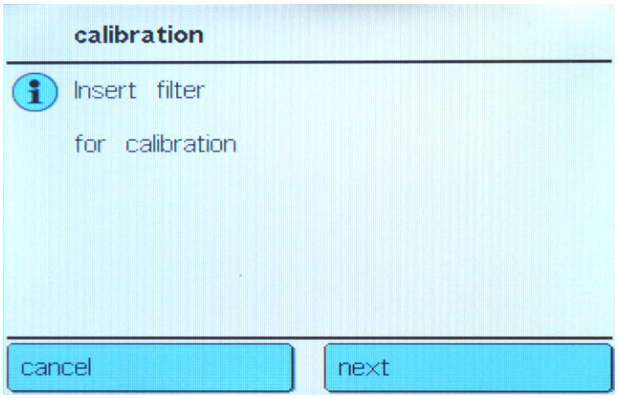
The values for $p_{Station}$ and $T_{Station}$ can only be estimated. As a rule the average annual values of air pressure and air temperature at the installation site are applied (presumed that the instrument will operate at the installation site for a period of at least one year). These values can only be taken from neighbouring meteorological stations. If no meteorological data are available, it is possible to refer to offices of local weather services. As a rule, required data can be determined with satisfactory.

7.4.4.2 Preparation for calibration

1. Prepare a calibrated flowmeter with a matching coupling adapter.
2. Prepare a filter holder with an inserted new filter. The same filter material has to be used as the material used for the subsequent sampling.
3. Note the position of the calibration point on the calibrated flowmeter (as a rule, a red mark). The position reading is performed in mm (printed scale division).
4. Determine the data for $p_{Station}$ and $T_{Station}$ (yearly average values for pressure and temperature at the installation site).
5. Determine the data for P_{outer} and t_{outer} (current pressure and current temperature at the calibrated flowmeter; if the calibrated flowmeter is fitted in the measurement cabinet directly on DH77, the inner temperature of the measurement cabinet has to be applied; if the calibrated flowmeter is operated in open air, the current outer temperature has to be determined).
6. Set the switch probe, heating to the lowest degree.
7. If the sampler is just processing a program, stop the program
8. Further, all data determined at the beginning of calibration are automatically logged to the currently active filter (printer, USB drive, interface).
9. Now calibration can be performed.

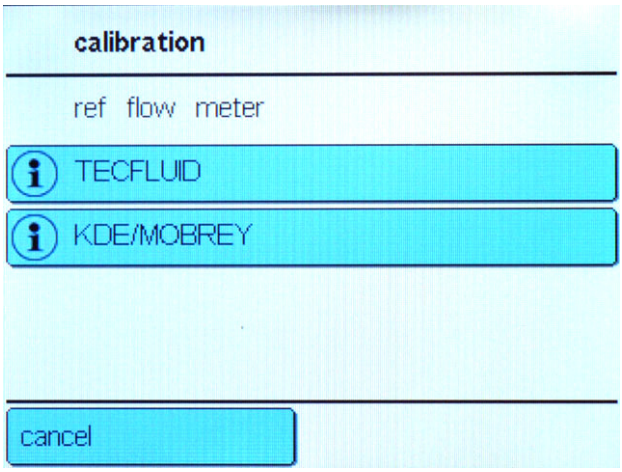
7.4.4.3 Start calibration

Start calibration as following > menu -> change program status -> Start calibration. After data logging exchange for the interrupted sampling cycle, the display indicates a requirement to insert a filter holder with a new filter into the filter holder magazine:



Further on, the calibrated flow meter has to be set (fitting should be preferably carried out between the air inlet on DH77 and inlet).
Check if the filter holder is in the flowing position.

Primarily select tne manufacturer of the reference measuring tube:



TECFLUID: 420 – 600 l/min
KDE/MOBREY : 100 – 1000 l/min

If a KDE/MOBREY reference tube is connected, the position of the calibration point has to be indicated.
Please indicate the position of the calibration point on the calibrated flow meter. The measuring tube has been furnished with a scale division in mm from 0 to 270 units.

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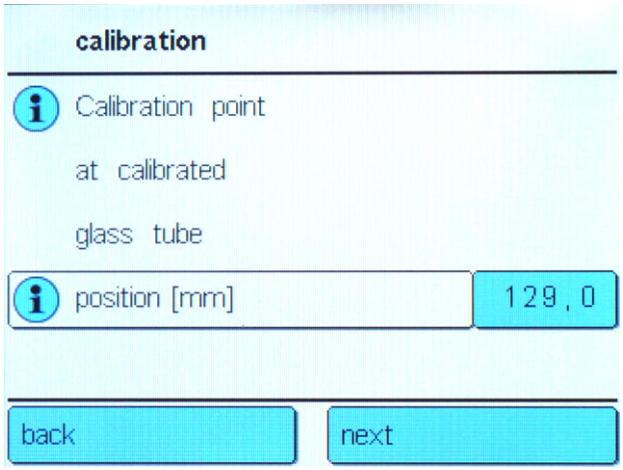
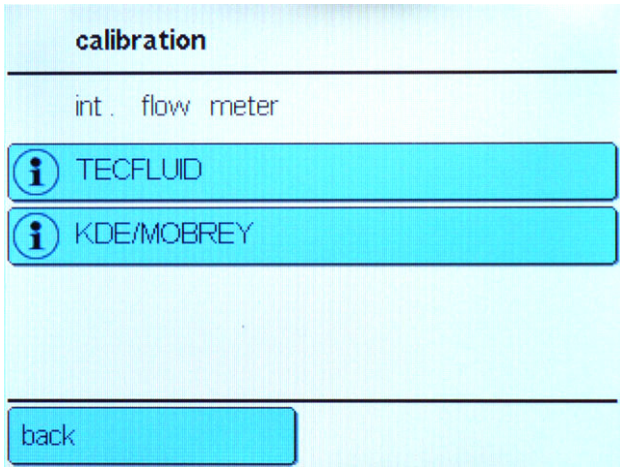
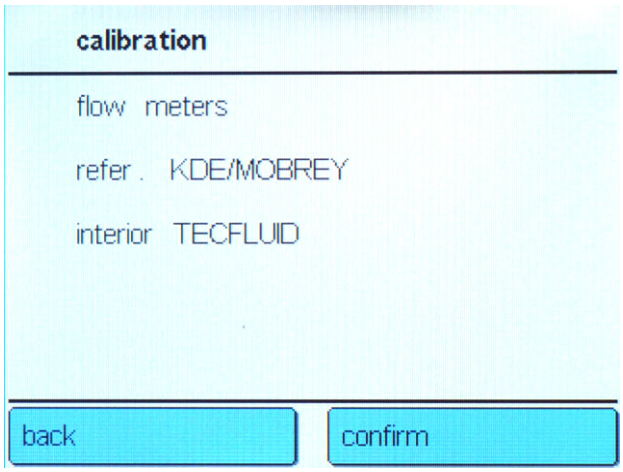


Subsequently you select the manufacturer of the internal measuring tube:



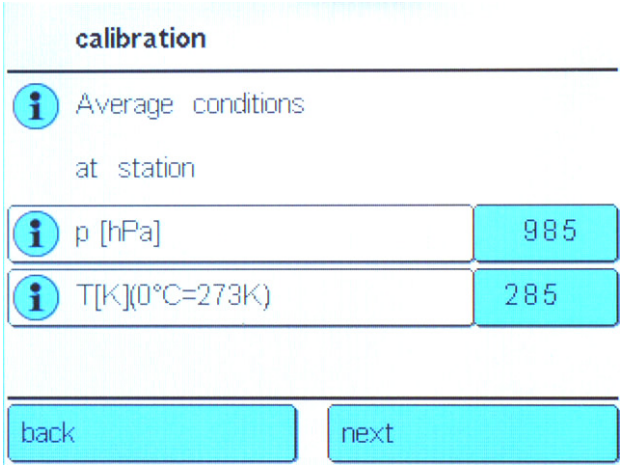
TECFLUID: 420 – 600 l/min
KDE/MOBREY : 100 – 1000 l/min

After the selection of the measuring tubes the display will show you an overview of the entered flow meters:

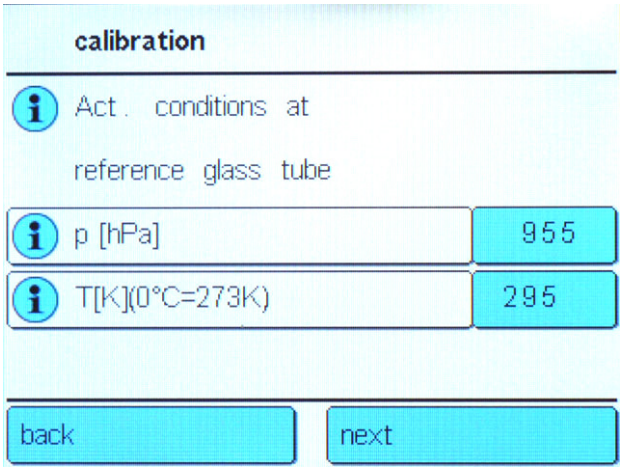


Please enter the annual average values of the air pressure and air temperature at the installation site.

Warning: The temperature has to be entered in degrees Kelvin!

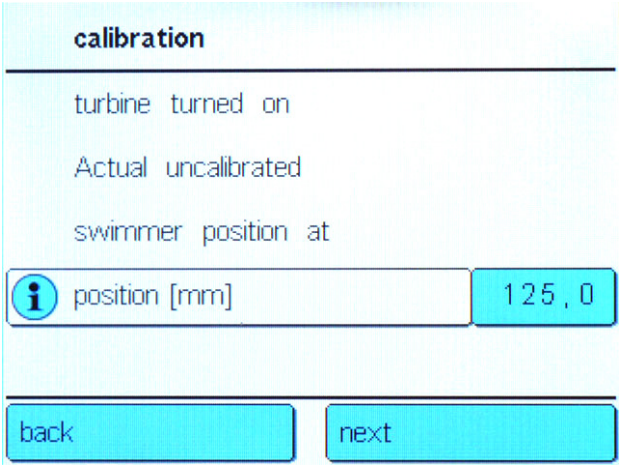


Please put in the current conditions at the calibrated flow meter:



After the values have been entered the blower will run up.

If the floater is at a stable position in the calibrated flowmeter, please read the current floater position from the calibrated flowmeter in mm and enter the determined value:



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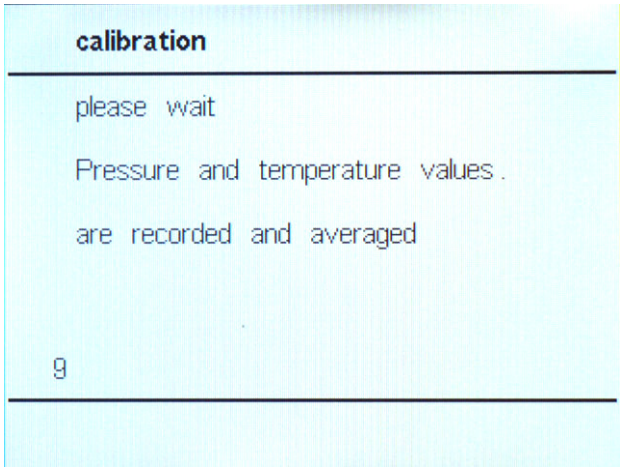
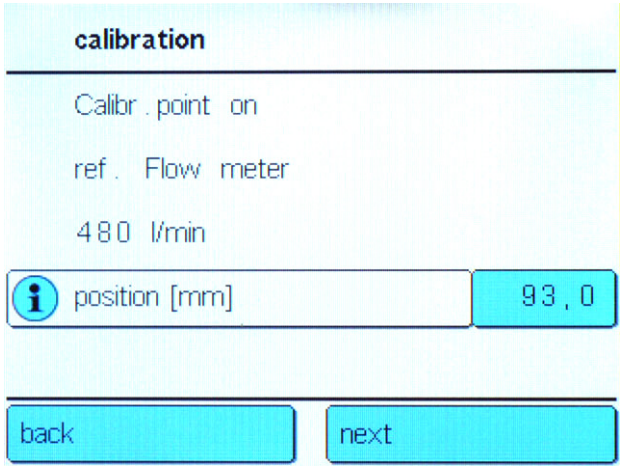
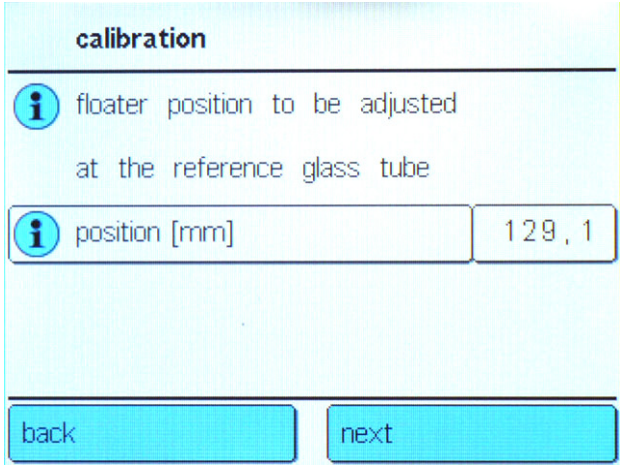
After the entering of the value please wait for approx. 15 seconds. During this period the temperature and pressure in the integrated measurement system will be determined:



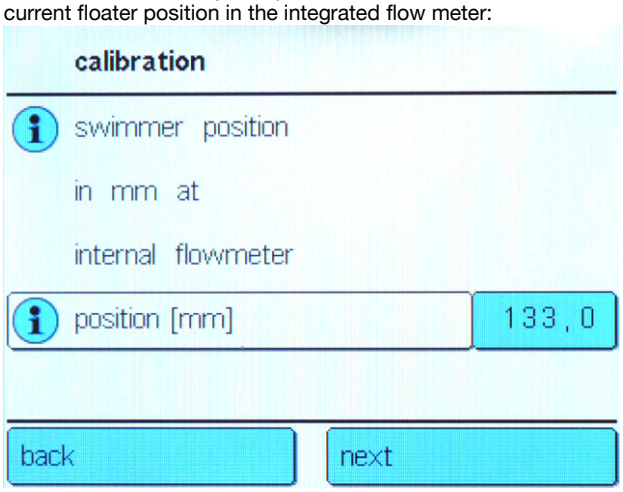
For TECFLUID reference measuring tube ONLY:
Please indicate the scale division at the displayed flow rate on the calibrated flow meter:



Then the display shows the data of the scale value to which the floater has to be set at the calibrated flow meter - by moving the photo-diode fork on the integrated flow meter- so that the instrument is calibrated for the specified station conditions:



After having carried out the setting, please confirm the process at the control system by touching the operation panel "next". This will be followed by a request to read out and to enter the current floater position in the integrated flow meter:



After entering this value (serving for checking only), all entered and internally calculated values are logged (printer, USB-drive, RS232). This protocol also transmits the propotional variation of the set flow.
The display indicates either passed calibration confirmation

"calibration successfully carried out"

or the failure indication message:

"calibration not possible"

The failure indication message is transmitted, if the entered floater position of the integrated flowmeter deviates too much from the calculated set point. This happens, when leakage occurred in the instrument. If so, please contact the Digitel company or its local representation office urgently.

Now, insert the filter holders for the next sampling program in the filter magazine (as the first filter holder, e.g. such filter holder that flown just before calibration, then in sequence, filter holders in designated sequence). By entering key "0", you will leave the calibration menu and the inserted calibration filter is exchanged.

Enter the start time for the next filter that is not fully deposited yet.
Start the program for the filter that is already half-deposited (previously having been automatically changed). This filter will be processed until the start time the next filter is reached! After having evaluated this filter, it should be checked that the sampling time is composed of the pre-calibration time and the time during the filter was processed in the pre-start filter program. Both the values have to be added manually!
Herewith the instrument is reset into original sampling condition, and the selected program is processed.
Unless a new sampling program is to be started after calibration, the calibration filter holder has to be exchanged manually from the flowing position: switch automatic "changer off" and enter the button "Manual change" for a short period of time (1 to 2 seconds). Then switch the automatic "changer off" on again. Now the filter holder which is present in the flowing chamber, is automatically changed.

7.4.4.4 Logging of calibration

At the end of calibration, the entered and internally calculated data are logged on the printer USB drive or serial interface (if

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available and activated). As an example, we provide here logging on the printer:

```
Di 19.03.02    08:36:43
calibration started

Di 19.03.02    08:37:53
Work

Di 19.03.02    08:38:15
Filter change

Di 19.03.02    08:38:31
Blower on

Di 19.03.02    08:40:43
calibration for 500 l/min
at av. station conditions
flow meters
interior   TECFLUID 420-600
refer.           KDE/MOBREY
p(act) outdoor  [hPa]:  950
T(act) outdoor    [K]:  295
pM (500 l/min)  [hPa]:  911
TM (500 l/min)    [K]:  297
p(average)      [hPa]: 1011
T(average)        [K]:  286
p(stand)        [hPa]: 1013
T(stand)          [K]:  273
pos. cal. point  [mm]:129,0
offset cal. Mark [mm]: -0,4
cal. pos(station)[mm]:129,9
pos. swimmer     [mm]:130,0
pos. int.(input) [mm]:131,0
pos. int.(target)[mm]:137,4
offset int. Scale[mm]: -6,4
offset filter    [mm]: -7,1
Q scale outd. [l/min]:500,8
Q amb. act.   [l/min]:523,4
Q scale indoor[l/min]:513,6
Q stand       [l/min]:476,3
change            [%]:  0,1

Di 19.03.02    08:43:17
Blower off

Di 19.03.02    08:43:17
end of calibration
```

7.5 Meaning of abbreviations

p(act)outdoor [mbar]:	Current pressure on the calibrated flowmeter
T(act) outdoor [K]:	Current temperature on the calibrated flowmeter
pM (500 l/min) [mbar]:	Current pressure on the integrated flowmeter
TM (500 l/min) [K]:	Current temperature on the integrated flowmeter
p(average) [mbar]:	Average yearly pressure at the installation site (station condition)
T(average) [K]:	Average yearly temperature at the installation site (station condition)
p(standard) [mbar]:	Standard air pressure
T(standard) [K]:	Standard air temperature
pos. Cal. Point [mm]:	calibration point position on calibrated flowmeter
Offset cal. Mark [mm]:	Difference between calibration position and calibration table 500 l/min position
cal. pos(Station) [mm]:	Position of the floater calibrated for average station conditions on the installation site in calibrated flowmeter
Pos. swimmer [mm]:	Floater position on calibrated flowmeter before calibration
pos. int.(Input) [mm]:	Floater calibrated position in the integrated flowmeter
pos. int.(target) [mm]:	Floater set-point position after calibration in the integrated flowmeter
Offset int. scale[mm]:	Difference between integrated flowmeter scale and calibration table (at Q amb. act.)
Offset filter [mm]:– Offset filter [mm]	Difference between calibrated flowmeter and integrated flowmeter on the basis of the filter resistance (depends on lower pressure in integrated flowmeter). Pos. int. (target) [mm] = cal. pos.(Station) [mm] – Offset cal. point [mm]
Q scale outd. [l/min]:	Flow rate on the calibrated flowmeter after calibration related to station conditions
Q amb. act. [l/min]: Current flow rate on the calibrated flowmeter after calibration at current conditions	Flow rate on the calibrated flowmeter after calibration related to station conditions
Q scale indoor [l/min	]: Set flow rate on the integrated flowmeter after calibration (this value should also automatically be taken over as an operation flow rate into control)
Q standard [l/min]:	Flow rate after calibration related to standard conditions
change [%]:	((Actual value – Target value) / Target value) * 100
Actual value ... Pos. Floater Target value ... Pos. (Station)	The flow rate variation of the previous calibration (positive values indicate an decrease, negative values indicate a increase in the flow rate due to re-calibration)

7.6 Determination of standard & operation volumes

Considering the pressure and temperature values determined during the sampling period on the integrated flowmeter, the values for $V_{Standard}$ (= Vs) or $V_{meas.system}$ (= VM) or in following for $V_{amb.}$ (= VA) are calculated from the equation (7) (Chapter 6.3.2) as listed below:
The equation (3) yields:

(8) $$Q_m = Q_{Scale\ indoor} \times \sqrt{(p_{ref} \times T_m)/(T_{ref} \times p_m)}$$

Q_m: average flow rate on the flowmeter during a sampling period
$Q_{Scale\ indoor}$: a set flow rate (e.g. automatically determined by calibration)
p_m: average pressure on the integrated flowmeter during a sampling period
T_m: average temperature on the integrated flowmeter during a sampling period

$$V_m = Q_m \times t_S$$

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V_m: transported volume at the flowmeter
t_s: sampling time

resp.

(9) $$c_M = \sqrt{(p_{ref} \times T_m)/(T_{ref} \times p_m)}$$

c_M: correction factor for flow rate on the flowmeter

while from the general gas equation $Q_1 \times (p_1 / T_1) = Q_2 \times (p_2 / T_2)$ and the equation (3) it follows:

(10) $$Q_s = Q_{Scale\ indoor} \times \frac{T_N}{p_N} \times \sqrt{(p_{ref} \times p_m)/(T_{ref} \times T_m)}$$

Q_s: average flow rate at standard conditions
p_N: standard pressure
T_N: standard temperature

(11) $$V_s = Q_s \times t_S$$

V_s: transported standard volume on the flowmeter

resp.

(12) $$c_S = \frac{T_N}{p_N} \times \sqrt{(p_{ref} \times p_m)/(T_{ref} \times T_m)}$$

cs: correction factor for the standard flow rate on the flowmeter

For transported operation volume determination on the sampling head, not all required measurement values are available for the control at the moment. Nevertheless the following calculation can serve a good approximation:

Air pressure determination (operation pressure) on the sampling head is performed by pressure measurement before and after sampling with the blower switched off on the integrated flowmeter and by calculating the average of both measurements .
Moreover, it is supposed that air passing through the filter is warmed up approximately by 3 K. As a result of that, the temperature decreased by 3 K on the integrated flowmeter is taken as the average temperature on the air inlet (operation temperature).
Consequently according to the equation (11), the operation volume on the air inlet under determined conditions can be derived:

(13) $$Q_A = Q_{Scale\ indoor} \times \frac{T_A}{p_A} \times \sqrt{(p_{ref} \times p_m)/(T_{ref} \times T_m)}$$

Q_A: average flow rate at operation statuss on the air inlet
P_A: operation pressure (determined indirectly)
T_A: operation temperature (estimated)

Further, it implies:

(15) $$V_A = Q_A \times t_S$$

V_A: transported operation volume on the air inlet
t_s: sampling time

or

(14) $$c_A = \frac{T_A}{p_A} \times \sqrt{(p_{ref} \times p_m)/(T_{ref} \times T_m)}$$

c_A: correction factor for operation flow rate at the air inlet.

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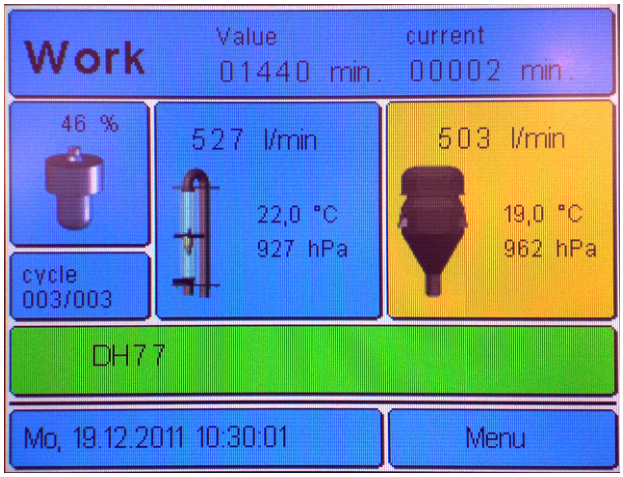
8 Programming

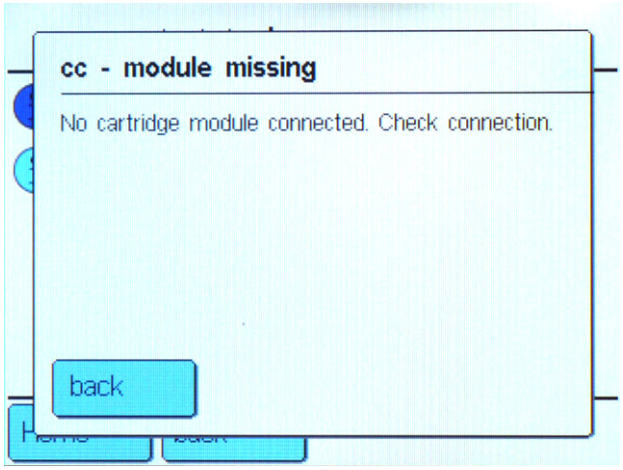
The programming will be carried out via the touchscreen on the front panel. The device will carry out a self test as soon as it is connected to the mains. As a confirmation that the self test is done successfully the basic indication, "home display", will appear. If this does not happen, please inform the Digitel service engineer.

8.1 Home display



The screen is divided in multiple panels. All the functions of the device can be programmed or current settings can be recalled via the operation panels.

At all selection and parameter panels you will find help texts in the corresponding sub menus. These help texts will be displayed as soon as you touch the information icon (graphical symbol).
Example help text:

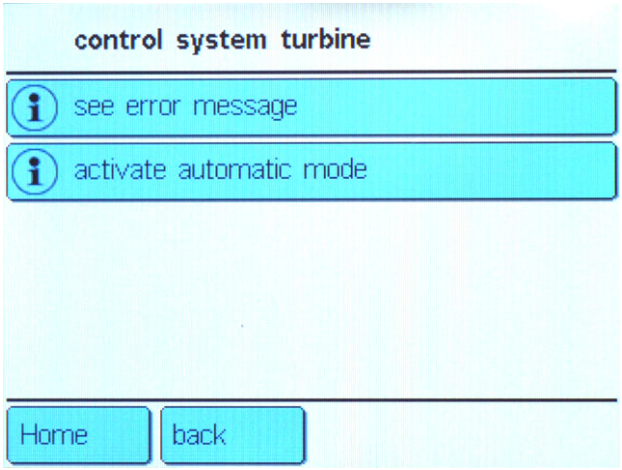


8.1.1 Operation panel "status display"

Here you can view the current program status. In the program status WORK and PAUSE you will find the adjusted and the already expired status times additionally displayed. By touching the operation panel you will get immediately to the program status menu. There you can start and finish the program, adjust status times or start calibration.

8.1.2 Operation panel "Turbine"

Here you can view the status of the turbinelf the turbine is on, the current capacity of the turbine can be viewed. By touching the panel the menu of the turbine starts:



8.1.3 Operation panel "cycle"

Here you can view the status of the filter cycle. By touching the operation panel the filter data menu is started. In this menu the filter data of the current filter will be displayed.

8.1.4 Operation panel "Flow meter"

Here you can view the current temperature, current pressure, as well as the current flow rate of the internal flow meter. By touching the panel the pressure/temperature menu will be started.

8.1.5 Operation "Ambient pressure / temperature recording"

Here you can see the current temperature, the current pressure as well as the current flow rate at the inlet.
ATTENTION: If there is no ambient pressure/temperature module connected and the setting "ambient pressure/temperature recording" is de-activated, the operation panel will turn into yellow. In this case, the ambient temperature will be estimated (temperature at flow meter –3K) as well as the ambient pressure by averaging (Average value of: pressure in measuring system before sampling and pressure in measuring system after sampling) will be calculated.
By touching the panel a menu with more detailed status information concerning ambient pressure/temperature module will be started.

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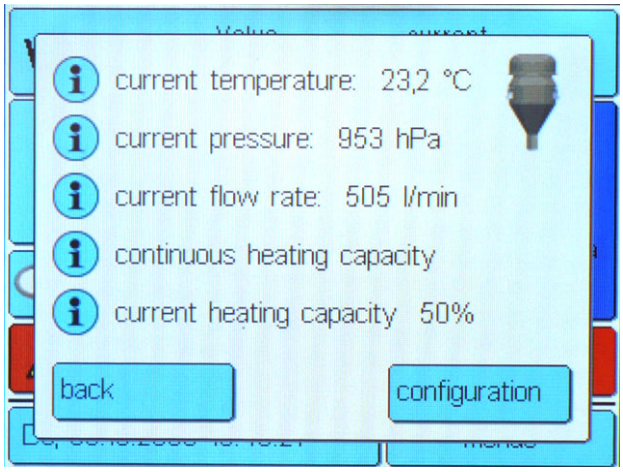
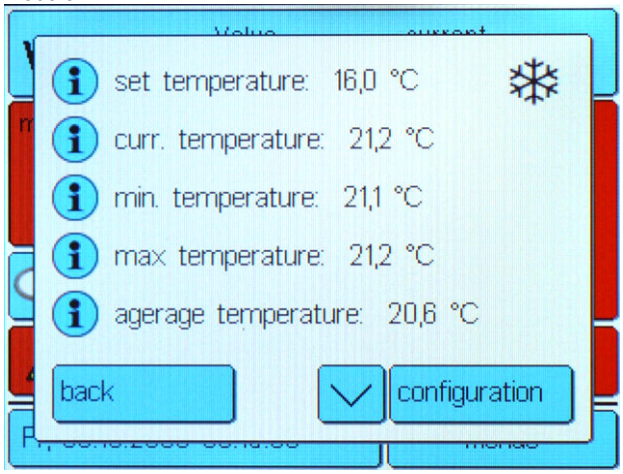


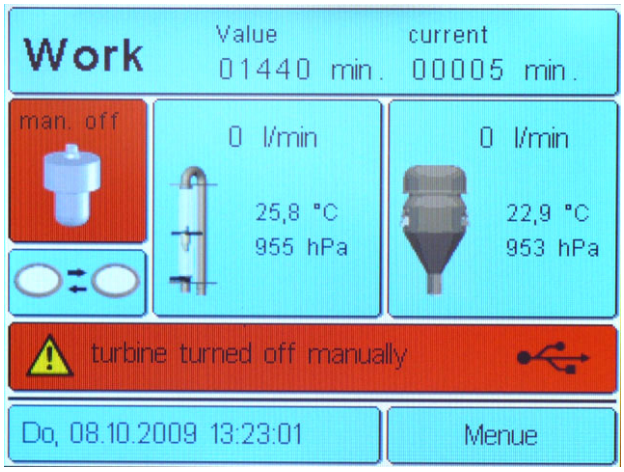
8.1.6 Operation panel "Options"

Here you can see the panel for connected options. In this example the option "Filter store room climatisation" is connected. By touching the panel another menu will be started and show you more status information regarding the connected module.

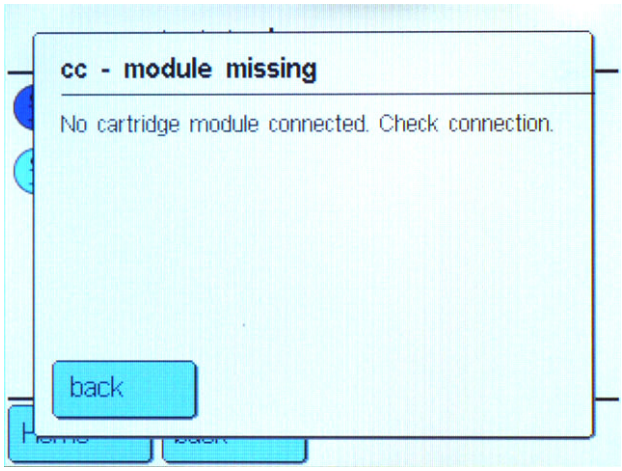


8.1.7 Panel "Status resp. error notification messages"

If the device runs free of errors, the operation panel is green and will show you the identification number of the device. Touching the panel won't show you anything. In case of error the operation panel turns into red and the error message will be displayed.



If more than one status message will be displayed these are shown at two second intervals. One after another. By touching the red operation panel a second menu will startand show you all current errors and status messages. Example:



8.1.8 Operation Panel "Date/Time"

Here the date and time of the instrument is shown. When touching the panel in this mode, the date and time values can be entered.

8.1.9 Operation Panel "Menu"

If this panel is chosen, the main menu is started. The settings can be changed and internal memory can be read out.

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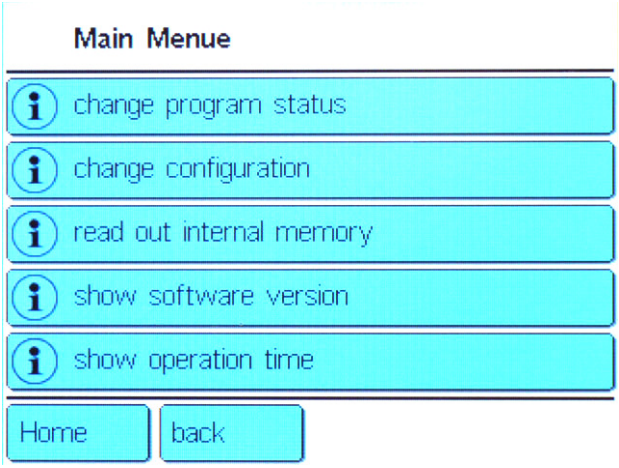
8.2 Main Menu

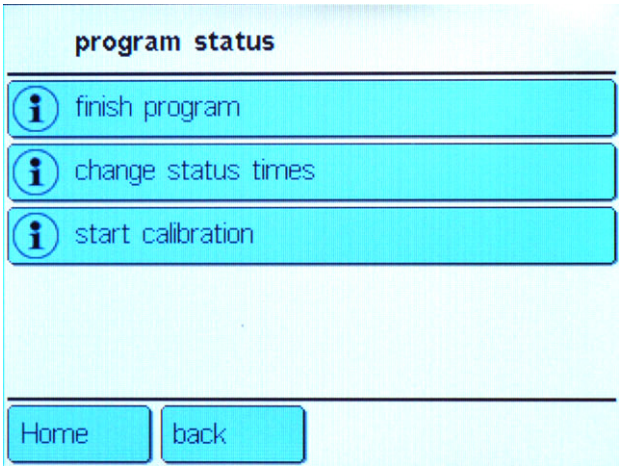
To get into programming mode, the field "Menu" has to be chosen when on home display. Then the Main Menu is displayed:



The submenus can be started here. The Main Menu can be reached chosing "Home" or "back".

8.2.1 Change Program Status

Depending on the program status, on the first line of this menu the options "Start Program" or "End Program" appear. The second and third lines "Change Status Times" and "Start Calibration" always appear:

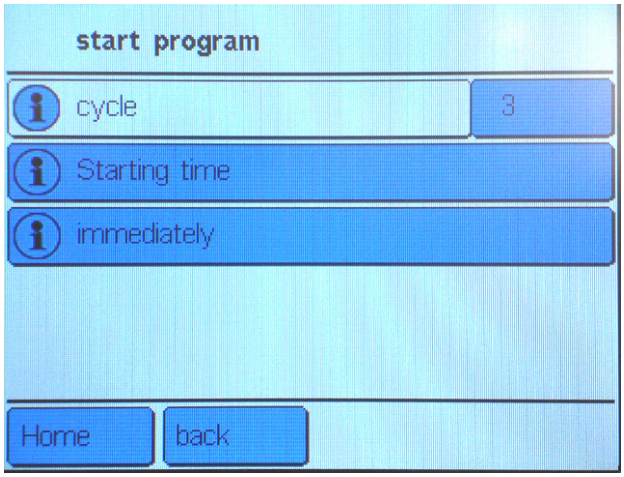


8.2.1.1 Stop Program

In this menu, the actual program can be stopped at any time. All filter and cartridge data is saved given out.

8.2.1.2 Start Program

Here the starting time is entered.



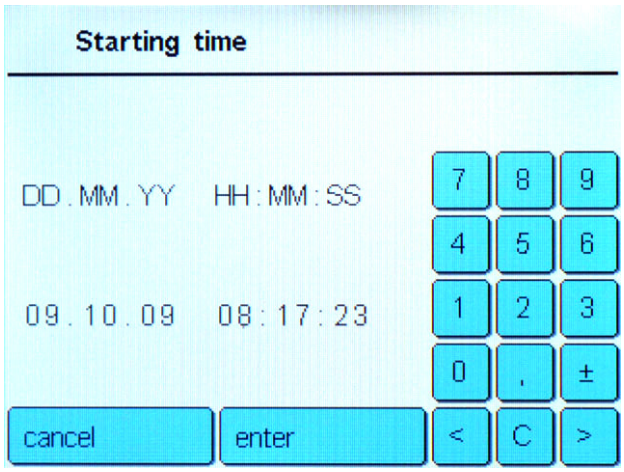
In this menu, you can select whether the program is to be started immediately or you wish to enter a particular date and time at which the program is expected to start.
Following programs could be chosen:
(Set the “cycle” first)

1. cycle = 0: endless continuous work-pause-work operation. At each change from Work to Pause the filterdata for the last work sequence are logged. There will be no accumulation of a single work-cycle. Every work-cycle should be regarded as an independent program sequence. It is acted on the assumption that in every pause cycle a manual filter change is effected.

2. cycle = 1: the inserted filter is charged with the chosen work period and the program is finished after the expiration of the pause period.

3. cycles > 1: After the expiration of the chosen pause period the program will be proceeded with work. This continuous work-pause-work operation will be repeated as long as the number of running cycles is defined
At each change from Work to Pause the filterdata for the last work sequence are logged. If the chosen number of running cycles is reached and the program is finished, the complete filter data are logged.

Furthermore you can choose if you want to start the program immediately or if you want to program a certain date and time for starting the program.



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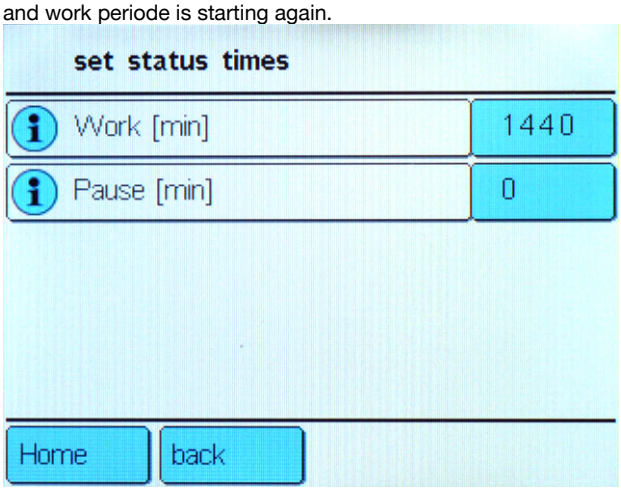
Now the designated date and time for program start can be entered. After chosing "Enter" the start time is transferred and main menu appears. Protocol:

```
Mo 04.05.09 10:30:00
Wait for start time
```

An additional menu item appears, if programming mode is chosen after the program start: prestart filter.
If this is activated, the blower turns on and the inserted filter stays in the air flow until the starting time is reached. Then, filter data is given out and the filter is changed.

8.2.1.3 Status times

In this submenu the times for work and wait state have to be entered. The work time is the time in minutes one filter stays in the air flow (blower on). The pause time is the time in minutes that is passed after the work periode before a new cycle starts and work periode is starting again.

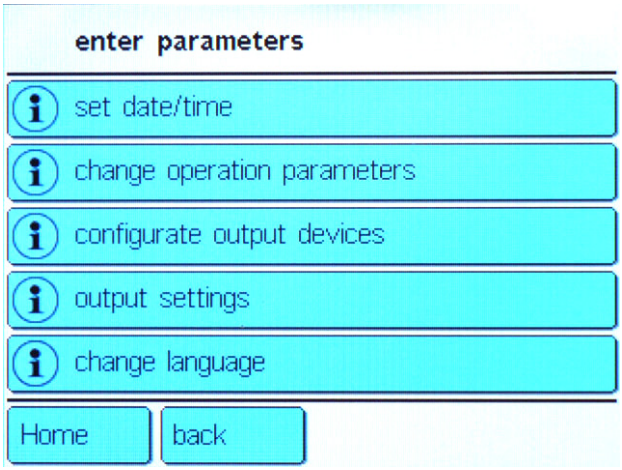


Chosing the "back" field, the submenu can be left without any change of the saved times. The entered times are read in minutes and can be used from 0 to 59999 minutes.

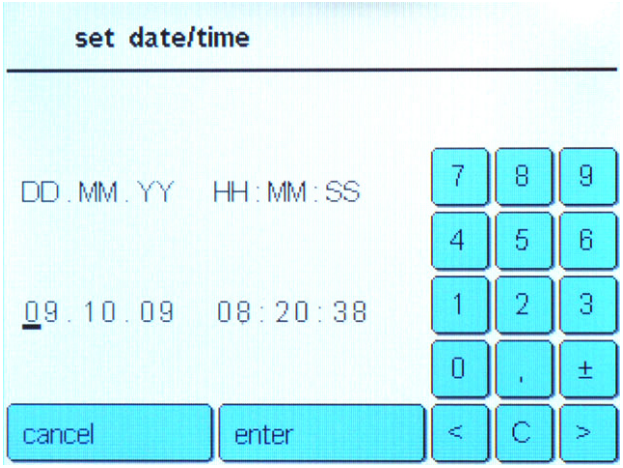
8.2.1.4 Calibration

In this menu the current program can be stopped and a calibration can be started at all times. All filter and cartridge data are saved and given out. For calibration see "7.4.4 Performing calibration".

8.2.2 Change Configuration

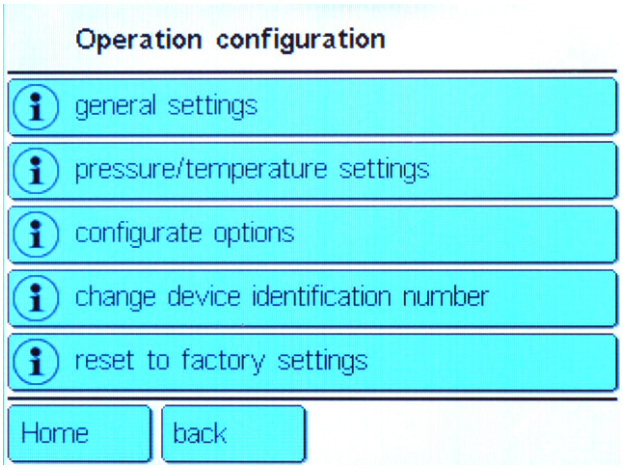


8.2.2.1 Insert Date / Time



An easy way to enter a correct time is to enter a time that is some seconds away and to confirm it with the "enter" button when the entered time is reached.

8.2.2.2 Change Parameters



8.2.2.2.1 General Settings

In the following table the settings are explained.

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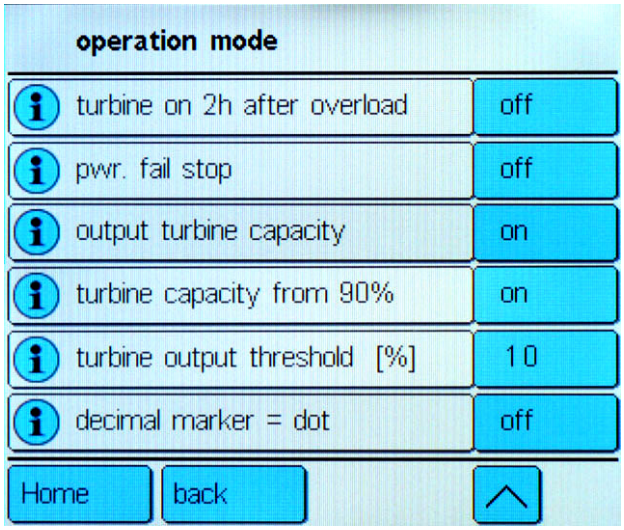
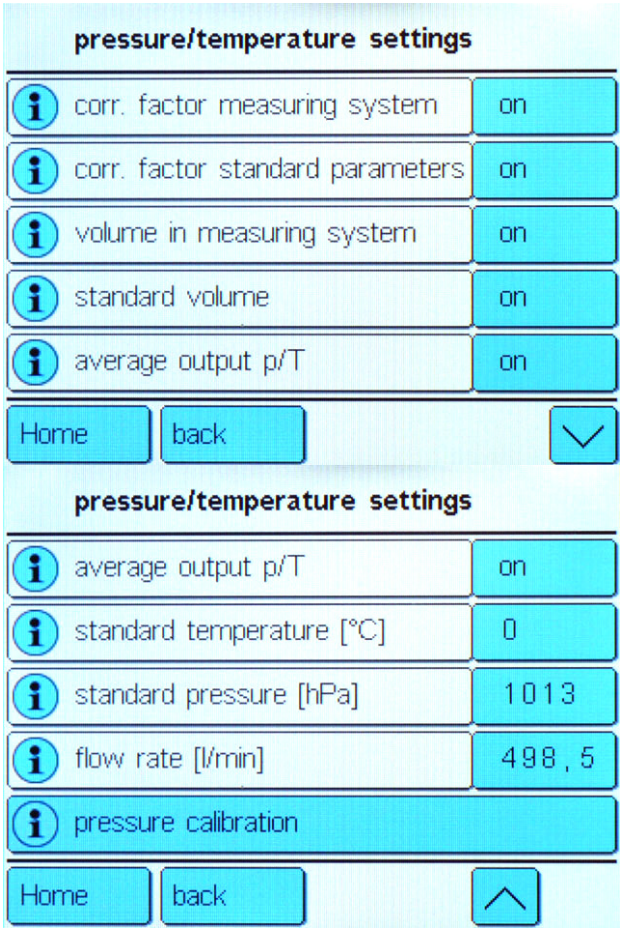


Menu item	Designation
Turbine on 2h after overload	Shall the blower switched-on after 2h after an overloading? "on": Restart after 2h after an overloading "off": Wait the remaining "Work" period with blower switched-off
Pwr fail stop	Shall the time be held after a power breakdown in the "Work" status? "on": The status period ("Wait", "Work" or "Pause") is held during power breakdown. It suggests that any filter (independent of a power black out) is deposited with the set "Work" time. Additionally it implies that any power breakdown shifts the next filter change time point by the period of power breakdown, so that the filter exchange time point cannot be defined any more. "off": After a power breakdown finishes, a power breakdown period is added to the corresponding status time (("Wait", "Work" or "Pause"). In this way the set cycle of filter exchange (e.g. filter changes always at midnight) is kept in any case. However in case of power breakdown, the inserted filter is not deposited with full "Work" time.
Output turbine capacity	Shall the blower load be logged (on printer, interface, USB drive)? "on": In addition to status messages "Blower on and "Blower off", the current blower load is logged. See lines 5 and 6, too. "off": No blower load is logged.
Turbine capacitya from90%	Shall log the blower load be logged at values >=90 %, only? "on": Logging of blower load is only performed at the values >=90 % (hereby the line 4 should be set on). "off": Logging of blower load is performed independent of its value (hereby the line 4 should be set on).
Turbine output threshold	How frequently shall the blower load be transmitted? Here the percentage rate can be pre-set, deciding at which variation of blower load the output is to be transmitted (the line 4 should be set on "on"). If a lower value (e.g. 1 %) is pre-set, there is a risk that the blower load will be be transmitted too frequently, as any variation
Decimal marker=dot	Dezimaltrennzeichen: "off": On USB drive, printer and touchscreen the decimal separator is a comma. "on": On USB drive, printer and touchscreen the decimal separator is a dot.

8.2.2.2.2 pressure/temperature settings

The details of the pressure and temperature submenu can be seen in detail in the below table.



Menu item	Designation
Correction Factor Measuring System	Shall a correction factor be transmitted for a pre-set flow? "on": After elapsing the "Work" period, the correction factor for pre-set flow or the entire measurement volumes is logged (printer, interface, USB drive). "off": No correction factor logging .
Correction Factor Standard Parameters	Shall the correction factor related to standard status be transmitted for pre-set flow? "on": After elapsing of the "Work" period, the correction factor related to standard status for pre-set flow or total volumes is logged (printer, interface, USB drive). "off": No standard correction factor

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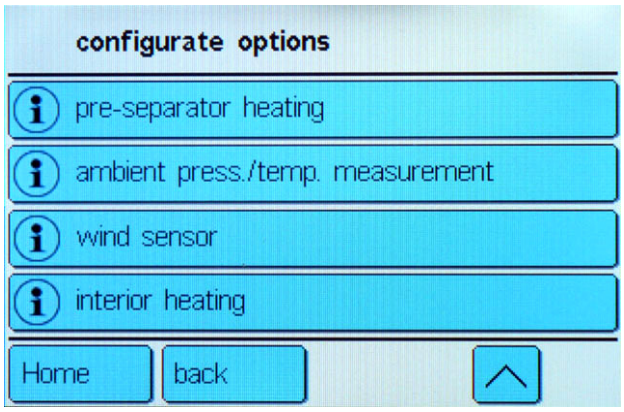
Menu item	Designation
	logging .
Volume in measuring system (m³)	Shall the measured volume value be logged? "on": After the "Work" period elapsing, the volumes actually transported at the measured environmental conditions are logged (USB, printer, interface). "off": No volume measured value logging.
Standard Volume (m³)	Shall the value of standard volume be logged? "on": After the "Work" period elapsing, the standard volumes (volumes at the pre-set standard statuss) are logged (printer, interface, USB drive), corresponding to the volumes actually transported (at the determined environment conditions). "off": No standard volume values logging .
Average output p/T	Shall the average pressure and average temperature be logged during sampling? "on": After the "Work" period elapsing, average pressure and average temperature during sampling are logged. "off": No average pressure and average temperature logging .
Standard Temperature (°C)	Here the standard temperature can be entered, to which standard correction factor or standard volume calculation is related.
Standard Pressure (mbar)	Here the standard pressure can be entered to which standard correction factor or standard volume calculation is related.
Flow rate	Here the flow can be entered, which is set in the flow-metering system. This value is required to calculate the measured volume or the standard volume value.
Pressure calibration	Here the pressure measurement can be calibrated. The measured value without correction is displayed. The correction factor is calculated by entering the current environmental pressure considered in all other calculations. Warning: During the input, the blower should be switched off. If semi-automated flow calibration is performed (see 7.4.4 Performing calibration), calibration of the pressure sensor is automatically performed, too.

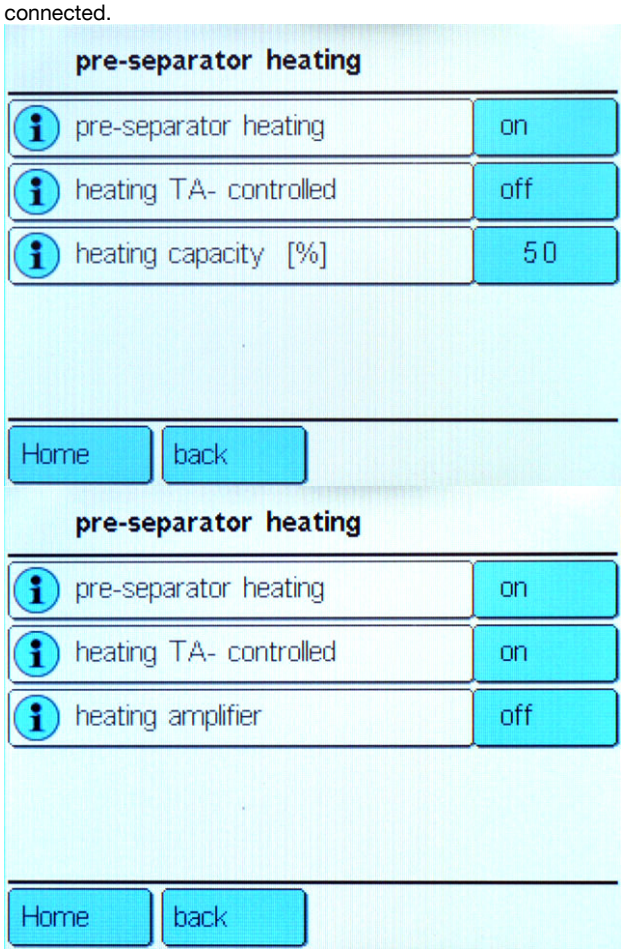
8.2.2.2.3 Configure Options

In the following chapters, the different options are explained in more detail.



8.2.2.2.3.1 Inlet heating

The heating of the inlet can be controlled depending on outside temperature if an ambient pressure/temperature module is connected.



Menu item	Designation
Inlet heating	"on": Inlet heating is turned on, more options are available. "off": Inlet heating is turned off.

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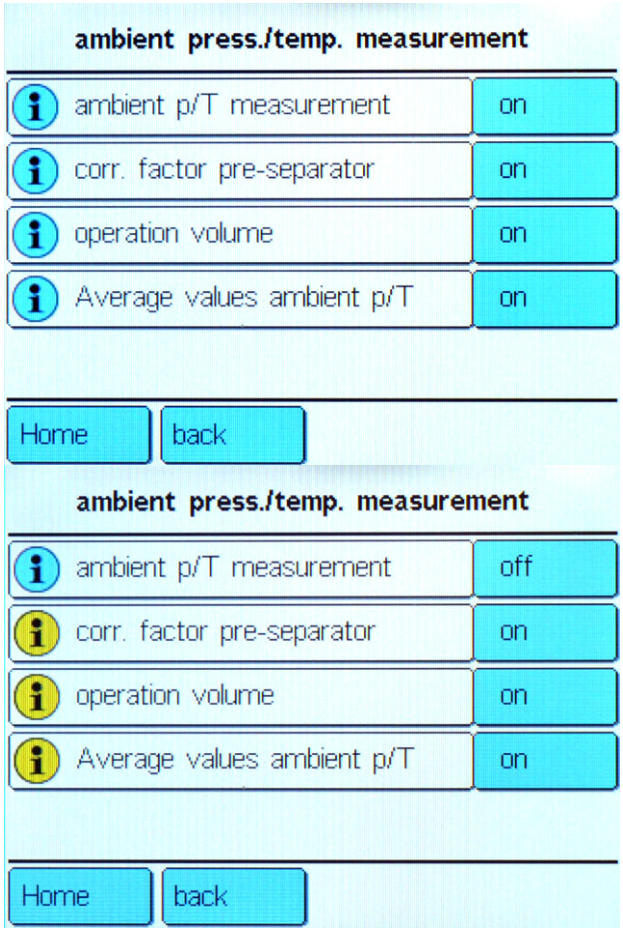
Menu item	Designation
Heating controlled by ambient temperature	"on": The power of the inlet heating is controlled by ambient temperature, For this, an outside temperature / pressure module has to be installed. "off": The inlet heating is driven by a constant power which can be chosen in this menu.
Heating amplifier	This setting is only available when the inlet heating is controlled by ambient temperature. "on": the heating is controlled in a way that the power is 100% at outside temperatures under –10°C and 0% at over 10°C. "off": "on": the heating is controlled in a way that the power is 100% at outside temperatures under –20°C and 0% at over 20°C.
Heating capacity	This setting is only available if the inlet heating is not controlled by ambient temperature. The heating is operated with the set power of heating.

8.2.2.2.3.2 Ambient pressure / temperature measurement

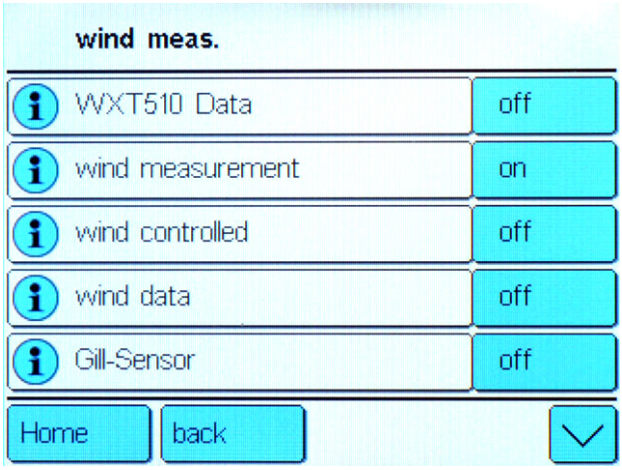
In the following table, the options for ambient pressure and temperature measurement are explained in more detail.



ambient pressure / temperature measurement	Shall ambient pressure and temperature be measured? "on": The current pressure and temperature at the inlet is measured. Attention: For this setting an ambient pressure/temperature module must be installed. "off": no pressure and temperature measurement. Attention: the ambient temperature is estimated (temperature at flowmeter –3K), the pressure is calculated (average of pressure in measurement sstem before and after sampling) This is why the info fields are then shown yellow.
Correction Factor air inlet	Shall the operation correction factor related to the air inlet conditions be transmitted for the pre-set flow? "on": After the "Work" period elapsing, the correction factor related to conditions on the air inlet for the pre-set flow or for total volumes is logged (printer, interface, USB drive). "off": No operation correction factor logging.
Operation Volume (m^3)	Shall the value of operation volume be logged? "on": After the "Work" period elapsing, operation volume is logged (printer, interface, USB drive). "off": No operation volume logging.
Average value ambient pressure / temperature	Shall the average value of ambient pressure / temperature be logged? "on": After the "Work" period elapsing, the mean value of ambient pressure / temperature is logged (printer, interface, USB drive). "off": No value of ambient pressure / temperature logging.

8.2.2.2.3.3 Wind Sensor

In the following table, the options for the wind sensor are explained in more detail. The wind sensor is an option and not integrated in standard instruments.



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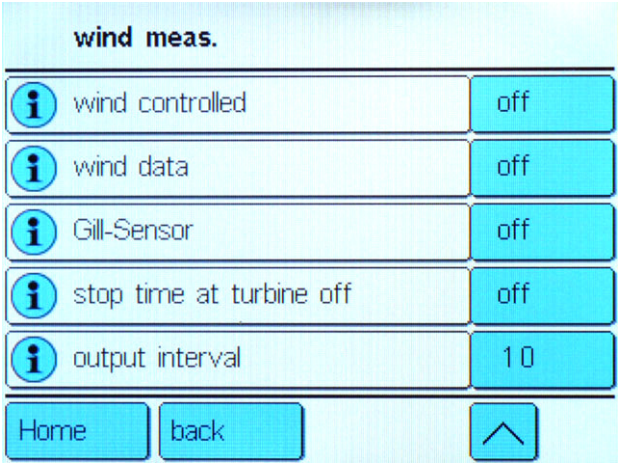


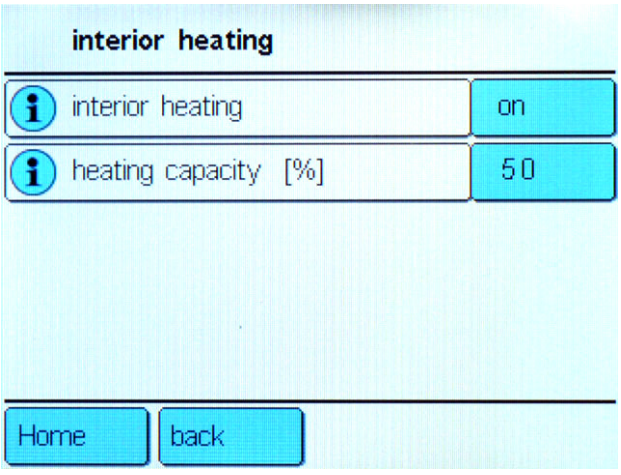
Menu item	Designation
WXT510 data	"on": A WXT510 wind sensor is plugged at the wind port. Additional to the wind data, humidity, rain and temperature are measured and logged. "off": No WXT510 sensor is plugged. The wind measurement is done by print Wind-03
Wind measurement	Shall wind data measurement be performed? "on": The wind data measurement is activated. Warning: This function can only be set if a corresponding measurement module is installed. "off": No wind data measurement
Wind controlled	Shall sampling period be wind controlled? "on": The sampler operation will be controlled by wind measurement. The sampler will run if the wind speed exceeds the limit values and wind direction is in the defined operating direction (+- half of operating angle) (provided that the sampler is in "WORK"- status). If one of the conditions is not fulfilled resp. the "work" period is elapsed, the blower will be switched off again. To prevent a frequent on- and off switching, the blower will be switched on for about 2 minutes after switching on (independent of the informations resulting from the measurements of the wind data). An exeption of this 2 minutes interval forms the achievement of the end of the "work" period. In this case the blower will be switched off immediately. "off": No wind controlled operation of the sampler
Wind data	Shall measured wind data be logged? "on": Measured and averaged wind data will be stored after a 5 sec. interval. Logging interval is independent of operating state. "off": No wind datal logging.
Gill-Sensor	Is a Gill wind sensor plugged? "on": A Gill wind sensor is plugged on serial port RS232. The serial port is used and cannot be used for control and data logging. "off" No Gill wind sensor is plugged. The wind measurement is done by print Wind-03.
Stop time at turbine off	Shall the sampling time be stopped when the blower is turned off?
	"on": Work time only counts when the blower is turned on by the wind control. "off": work time counts independently from wind control. Die Workzeit wird
Output interval	Here, the wind data logging interval (in minutes) can be entered, to which wind measurement mode is related. The logged wind data will be averaged over the dermined time.

When wind control is turned on more settings are available.

Menu item	Designation
Speed threshold	Here, the limited wind speed in m/s can be entered, to which wind controlled operating mode is related. The sampler will run if the wind speed exceed the threshold and wind direction is in the defined operating direction (+- half of operating angle).
Operating angle	Here is defined how the operating angle is related to the wind direction. If the average value of the measured wind direction value lies within the range of the angle that is covered by the preferential wind direction + - half of the operation angle, the blower will be activated.
Operating direction	Here is defined which wind direction is the preferential one. Mind that the wind direction is aligned to the north correctly. The prefential wind direction shows the direction from which the wind blows if the HVS should be activated. The input will follow in degrees.
Averaging time	Here is defined how long the measured wind data should be averaged before they are utilised for control of the HVS. The input will follow in degrees. This averaging time don't affect averaging of wind data logging.

8.2.2.2.3.4 interior heating

In the following table, the options for the indoor heating are explained in more detail. This heating is an option and not integrated in standard instruments.



Interior heating	"on": Heating is on, further settings are displayed.

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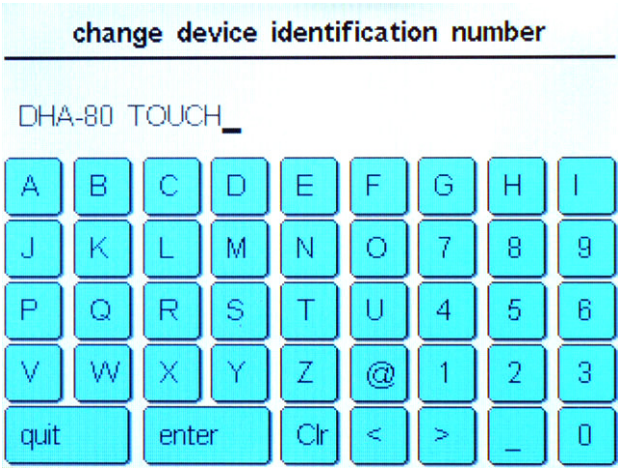
	"off": Heating is turned off.
Heating capacity	The heating is operated with the set power.

8.2.2.2.4 Change instrument ID

When you log the instrument identification upon every sampling time transmission, you have to activate the instrument identification:
Warning: The first 3 characters of the instrument identification are transmitted in the Bayern-Hessen protocol in "series no." field. If the Bayern-Hessen protocol is applied, the first three characters have to be numerical or blank. Then, an ID with max. 27 characters can be defined.

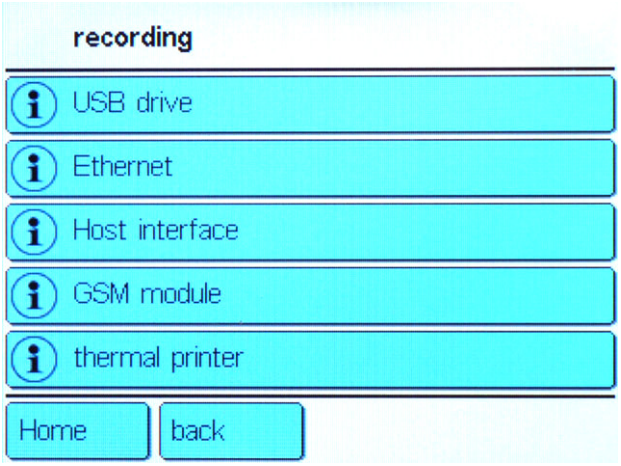


8.2.2.2.5 Default (factory setting)

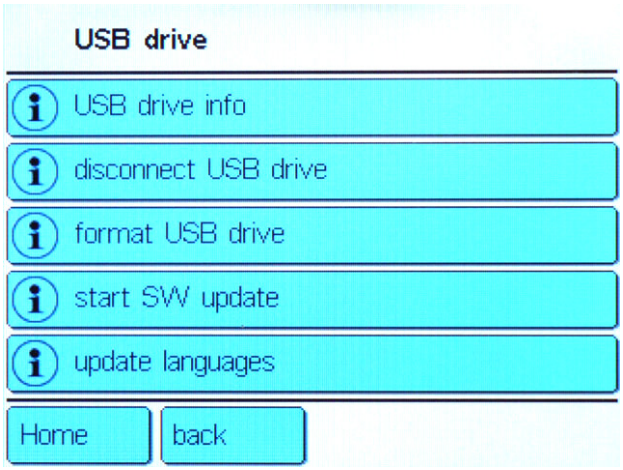
All adjustable parameters are reset to the factory settings.

8.2.2.3 Configure recording

In this menu, recording instruments can be configured. In the following chapters, there is a more detailed description of those menus and their submenus.



8.2.2.3.1 USB drive

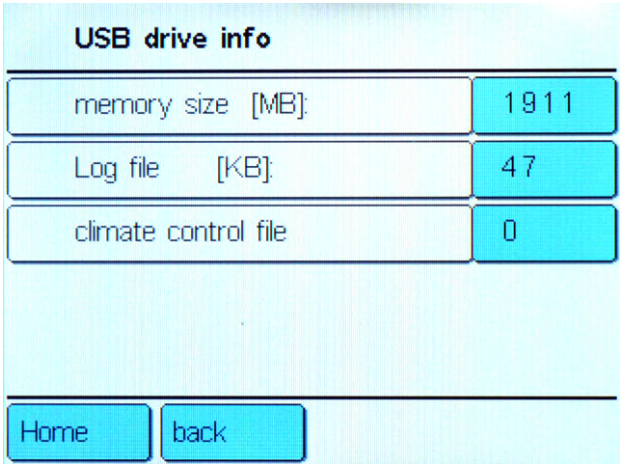


Filter data, status messages and wind data are stored in the internal flash module of the control. Filter data, status messages or failure messages are stored in the logfile. The wind data in the wind file. Up to 10,000 entries are recorded per file.

With the plugged-in USB drive the recorded data are stored simultaneously on the internal memory as well as on the the USB drive. That is the reason why the USB drive can be removed any time. (Attention: please consider the mode removal USB ! See 13.2 Removal USB drive)

After the removal of the USB-drive the control only stores the data records on the internal memory. By plugging-in the USB-drive anew the user is asked if all the recorded data should be stored on the USB-drive since this one has been unplugged.

8.2.2.3.1.1 USB drive info



The size of the memory is displayed in MB. The saved files are listed below showing their sizes.
Log file: filter data, status records
Climate control file: temperature of filter storage and clima status
Wind file: wind data

8.2.2.3.1.2 Disconnect USB drive

When this menu is chosen, a message appears: "USB drive can now be disconnected". This is used to plug out the drive savely.

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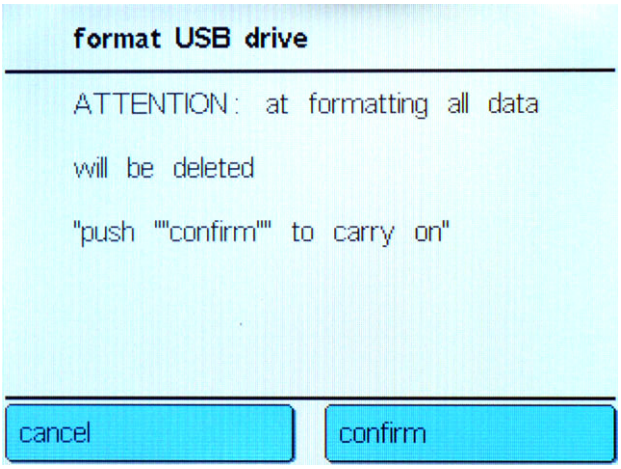
8.2.2.3.1.3 Format USB drive

In this menu, the USB drive can be formatted. To avoid unintended formatting, the formatting has to be confirmed once again:



After this confirmation, the USB drive is formatted. ATTENTION: At formatting, all saved data on the USB drive will be lost! After formatting, one or two data files will be made depending on the configuration. The structure of the data files is shown in chapter 13 Data recording with USB-drive.
Formatting of the USB drive takes some seconds. After successful formatting, the USB info menu is shown.

8.2.2.3.1.4 Start Software Update

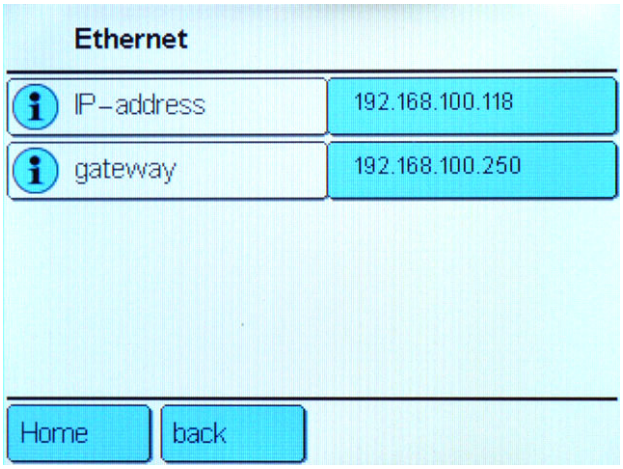
When this button is used, the firmware update menu is started. This menu only appears if the files "DIUPDATE.BIN"(new firmware) or "DI_FPGA3.BIN"(new FPGA – File" are on the USB drive.
To avoid unintended over writing of firmware, the option has to be confirmed. After the confirmation, the new firmware is read from the USB drive and the control is newly programmed. Thes procedure may take several minutes. After successful firmware update the control is restared.

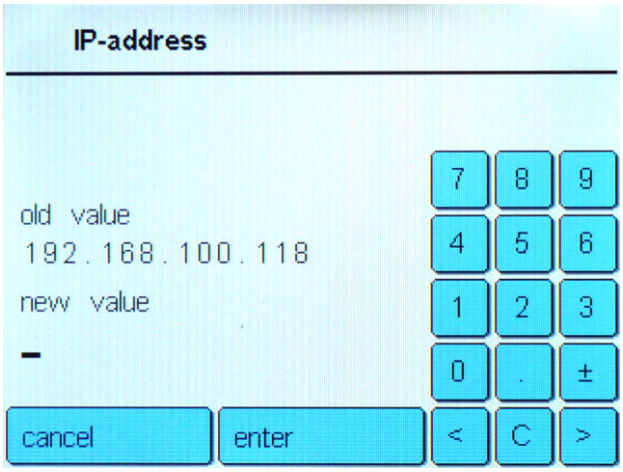
8.2.2.3.1.5 Update Languages

When this button is used, the language update menu is started. This menu only appears if the file "DI_TEXTE.TXT" (new text files, additional languages) is on the USB drive. The new texts can now be copied from the USB drive. After successful overwriting the new texts are displayed on the screen.

8.2.2.3.2 Ethernet

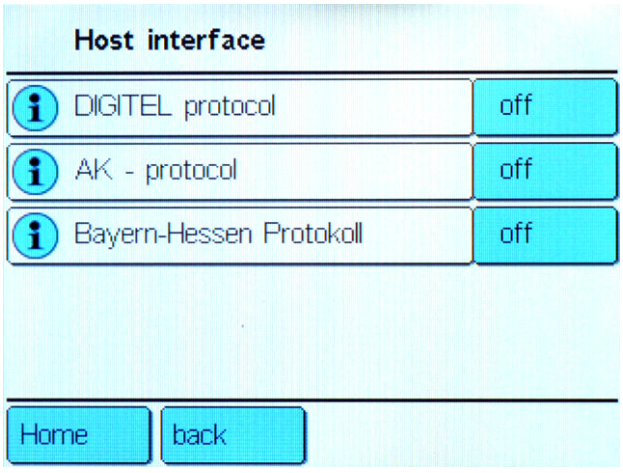
Here the IP-address and the gateway can be entered:





The values are confirmed using the "enter" button.l
ATTENTION: The new IP-address only is entered into the system after a restart!
When chosing "cancel", the menu can be left without any change of values.

8.2.2.3.3 Host-Interface



Now you can select the required protocol format for the host interface:

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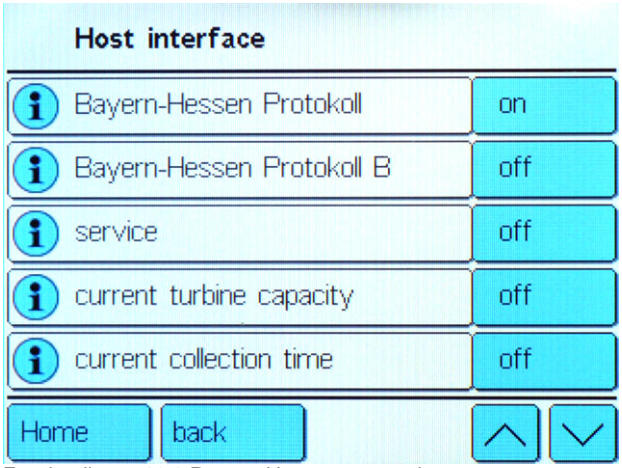
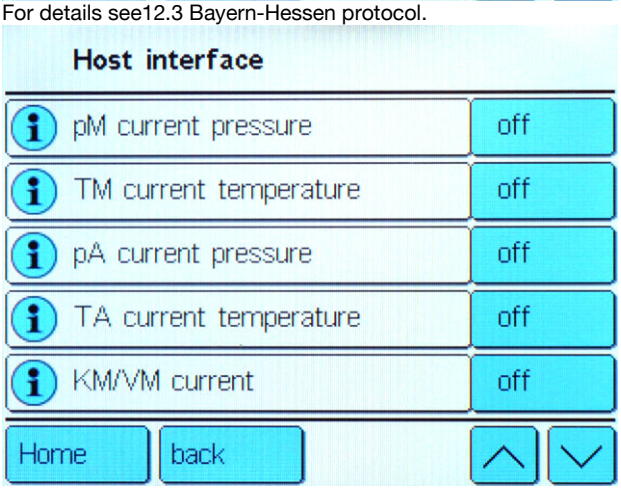
DIGITEL–Protocol
ASCII protocol. When this protocol is activated, all filter data, failure and status messages are given out on the serial port. For details see 12.2 Digitel protocol.

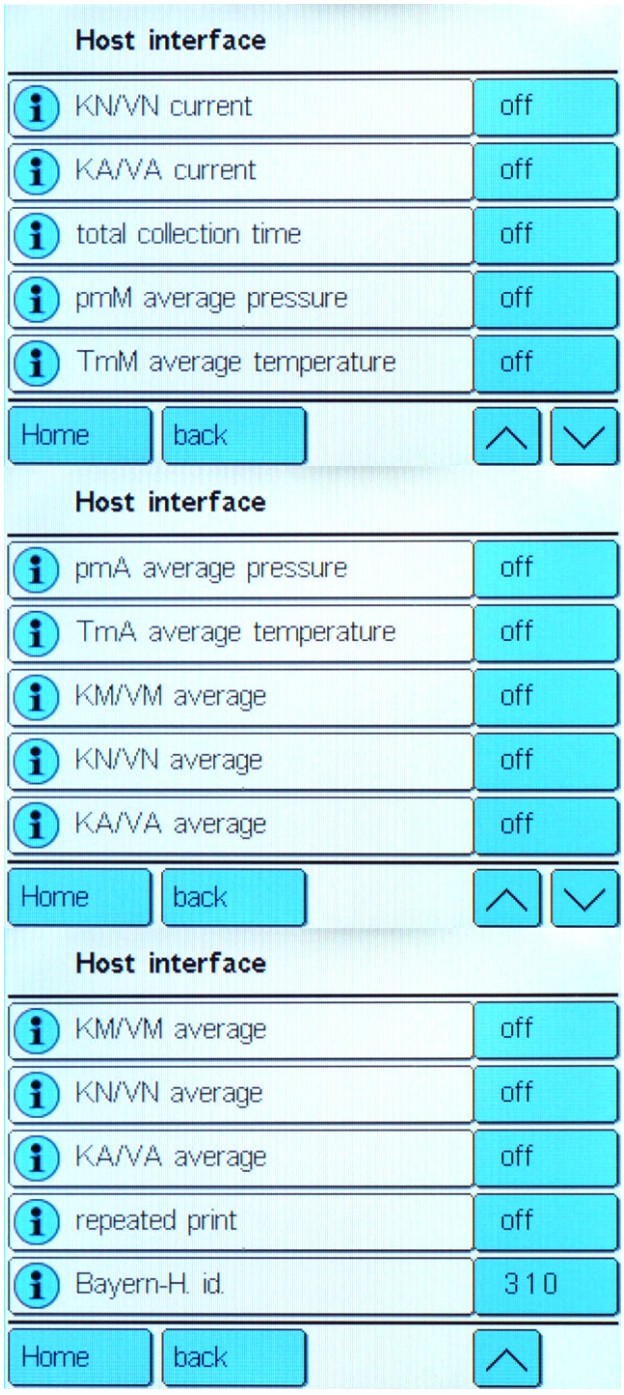
AK-Protocol
Here you define that the AK protocol will be used for communication with the host system. For details see 12.4 AK-Protocol.

Bayern-Hessen Protocol
When you set the "Bayern-Hessen protocol on", the display changes to the Bayern-Hessen protocol sub-menu setting:



For details see12.3 Bayern-Hessen protocol.





GSM Module
Here the GSM-module can be activated. If a GSM-module is plugged and activated, all filter data and status and failure reports are polled by the module, saved and periodically forwarded to a GSM-receiver.

Bayern-Hessen Protocol B
Setting the "Bay-Hes-P. B on", determines that a Bayern-Hessen protocol special extension is applied (2 400 Baud, varied occupation of operation-status bit, see the annex).

Service

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Setting "Service on", determines that a special input is inquired and that, at any status inquiry, the input status is determined on the host computer.

Output mode
Here you define which values are to be shown in the protocol.

blower load:	act. blower load
act. collecttime:	elapsed collect time for the actual filter
Press. meas.:	actual pressure in measurement system
Temp. meas.:	actual temperature in measurement system
act. corr. meas.:	Actual correction factor for pre-set flow through measurement system related to measured environmental conditions in measurement system.
act. corr. std.:	Actual correction for pre-set flow through measurement system related to standard conditions.
act. corr. amb.:	Actual correction factor for pre-set flow through measurement system related to estimated conditions on the air inlet (air pressure average value before and after sampling on the sampling head and flow-meter average temperature - 3K).
collecttime:	Elapsed collect time of the last completed filter. This value will be shown only one time or until "C" command is received (dependent of the parameter "repeated print"). If no "C" command is received the value will be shown until completion of the actual filter.
p avg.:	Average pressure conditions in the measurement system of the last completed filter during the sampling period. This value will be shown only one time or until "C" command is received (dependent of the parameter "repeated print"). If no "C" command is received the value will be shown until completion of the actual filter.
Temp avg.:	Average temperature conditions in the measurement system of the last completed filter during the sampling period. This value will be shown only one time or until "C" command is received (dependent of the parameter "repeated print"). If no "C" command is received the value will be shown until completion of the actual filter.
p avg. amb.:	Average pressure conditions on the air inlet of the last completed filter during the sampling period (air pressure average value before and after sampling on the sampling head). This value will be shown only one time after filter change (otherwise value "0") or until "C" command is received (dependent of the parameter "repeated print"). If no "C" command is received the value will be shown until completion of the actual filter.
T avg. amb.:	Average temperature conditions on the air inlet of the last completed filter during the sampling period This value will be shown only one time (otherwise value "0") or until "C" command is received (dependent of the parameter "repeated print"). If no "C" command is received the value will be shown until completion of the actual filter.
avg. cM/VM:.	Average correction factor for pre-set flow or volumes actually transported through measurement system of the last completed filter related to measured environmental conditions in completion of the actual filter
avg. cs/Vs:	Average correction factor for pre-set flow or volumes actually transported through measurement system of the last completed filter related to standard conditions. This value will be shown only one time or until "C" command is received (dependent of the parameter "repeated print"). If no "C" command is received the value will be shown until completion of the actual filter.
avg. cA/VA:	Average correction factor for pre-set flow or volumes actually transported through measurement system of the last completed filter related to estimated conditions on the air inlet (air pressure average value before and after sampling on the sampling head and flow-meter average temperature - 3K). This value will be shown only one time or until "C" command is received (dependent of the parameter "repeated print"). If no "C" command is received the value will be shown until completion of the actual filter.

Repeated print
Here you define if some values will be shown in the protocol only one time or until "C" command is received. If no "C" command is received the value will be shown until completion of the actual filter.

Identification
Here you set the identification (measurement instrument or measured value identification address). It is supposed that the set identification corresponds to the first measured value to be transmitted. The following measured values are provided with the next higher identification address (see the above-shown chart).
Ensure that the instrument address for HVS is set as "310". If no identification has been entered, "310" is similarly accepted for identification of the first measured value.
Valid input range: from 000 to 994

Baud Rate
Depending on the chosen protocol, there are presettings for Baud rate:
- DIGITEL-Protocol: 2400 Baud
- AK- Protocol: 2400 Baud
- Bayern Hessen Protocol: 1200 Baud
- Bayern Hessen Protocol B: 2400 Baud

Baud rate can be set manually for DIGITEL-protocols. This rate only is valid for this protocol and will be set back at the next change of protocol. Valid settings: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200

Remote control
If you operate the instrument using an external controller and you lose connection to this controller, you have to communicate with the HVS controller that has to be re-switched into the autonomous operation status. For that there is an applicable menu point which is only visible if the remote control is activated. If "Remote Off" is chosen, the control changes to autonomous mode.

8.2.2.3.4 Thermo printer

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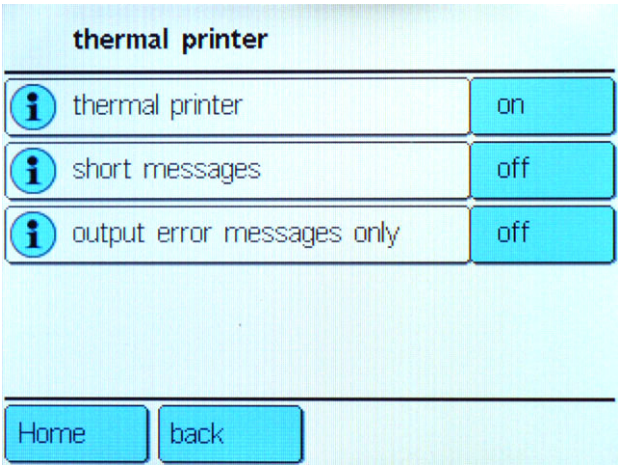


Thermo Printer	Shall there be a protocol on the thermo printer? "on": there is a protocol "off": there is no protocol
Short protocol	Shall the protocol be in a short form? "on": short form "off": normal protocol
Only failure	Shall only failure reports be logged? "on": Only failure reports are printed. (overload, changer jammed, last filter, program start, program stop) "off": all status and failure reports are printed. Number of printed status reports depends on other settings.

8.2.2.4 Print settings

Current program settings are printed to plugged, activated ports.

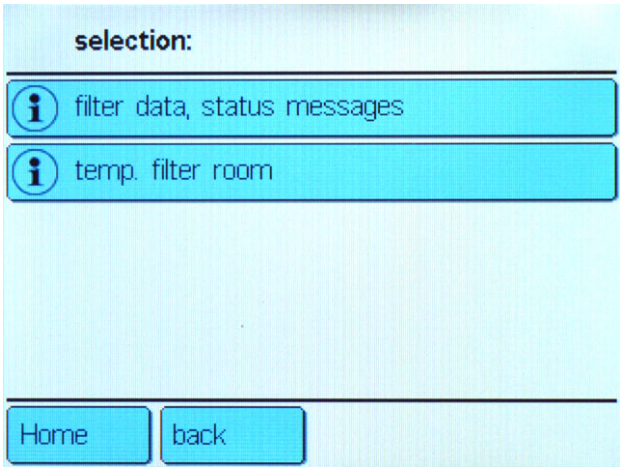
8.2.2.5 Change languague

All available languagues are shown in English independently of the chosen languague. After a languague has been chosen, all displays and prints are in this languague.

8.2.3 Read out internal memory

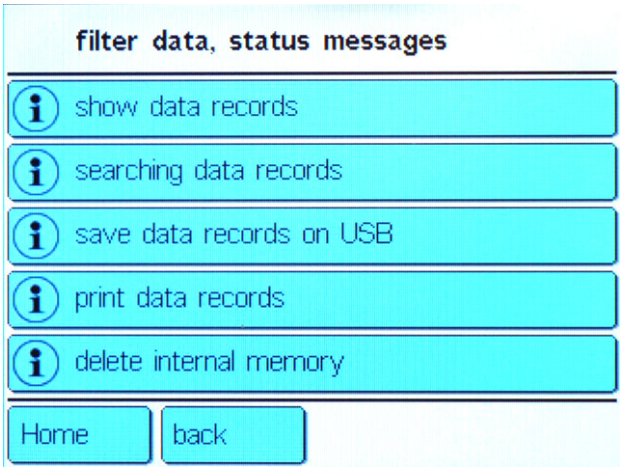
Filter data, status reports and data from optional instruments are logged in the internal flash memory. Filter data, status and failure reports are saved in logfiles, data from options is saved in separate data files. Up to 10000 entries can be made per file. Those entries can be shown on the display, printed on the thermo printer or on the USB drive.

First, the following menu appears:

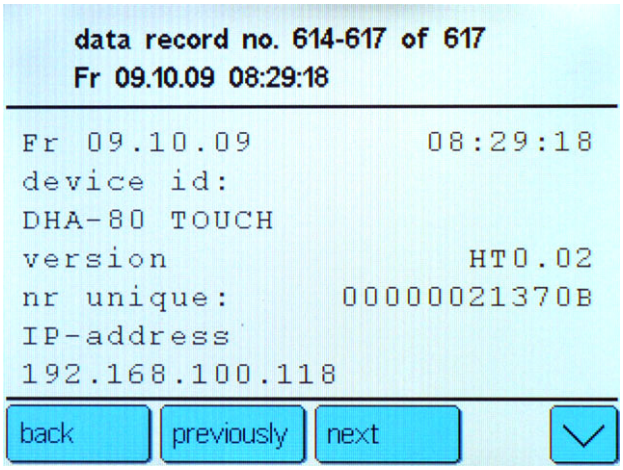


Here the file to be displayed can be chosen.

After having chosen a protocol, the following actions can be taken:



8.2.3.1 Show protocol



In this menu the las status reports are shown in chronological order on the display. Every entry is shown with date/time information. Up to 10000 reports can be showed. Using previous and next buttons, previous and next entries are shown. In the first line of every entry, the number can be seen. If on the first

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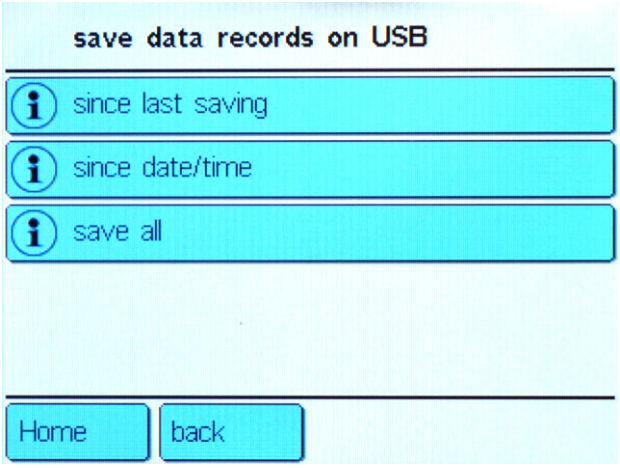
entry "previous" is chosen, the last entry appears, if on the last entry "next" is chosen, the first entry appears.
For longer entries, the scrolling button can be used to see all the information.

8.2.3.2 Search protocol

In this menu, an entry can be searched by date/time. The newest entry after the searched date/time is displayed.

8.2.3.3 Save protocol



In this menu, the protocol can be passed onto the USB drive.

8.2.3.3.1 From last save

All entries from last save on are saved.

8.2.3.3.2 From date/

All entries from set date/time on are saved.

8.2.3.3.3 Save all

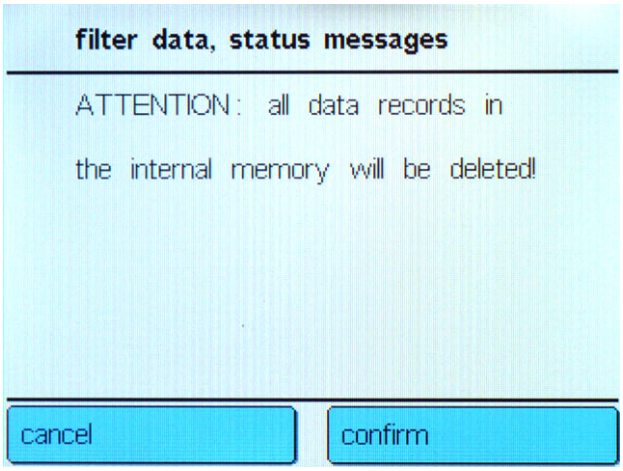
All entries in the chosen file are saved.

8.2.3.4 Print protocol

In this menu the protocol can be transmitted to the USB or printer. The same menu as in "Save Protocol" appears.

8.2.3.5 Delete protocol

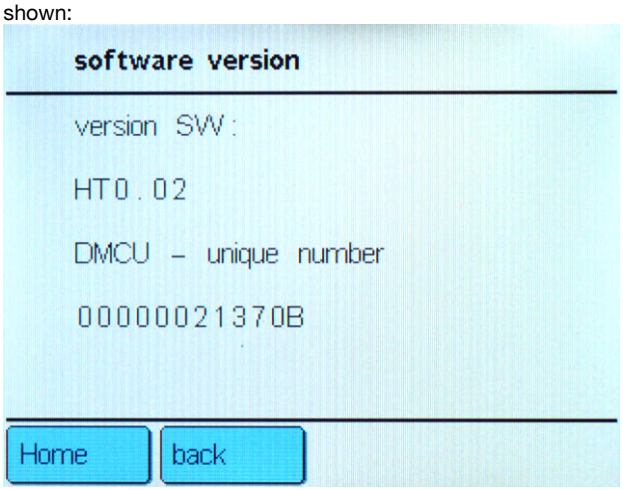
To avoid unintended deleting of memory, the following question appears:



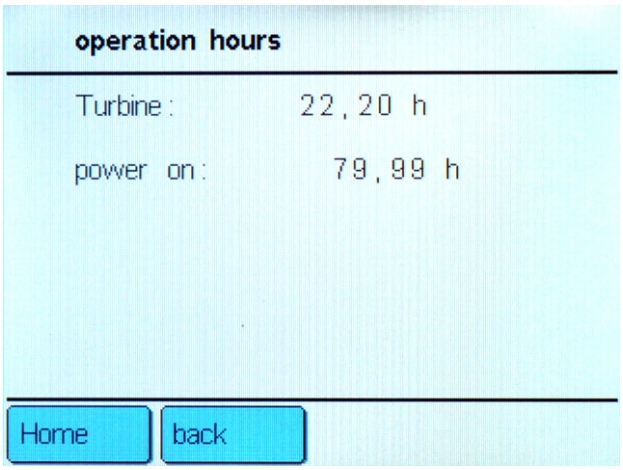
After the confirmation, the memory for the chosen file is deleted completely!

8.2.4 Show software version

In this menu the installed software version and DMCU code is shown:



8.2.5 Show working hours



In this menu working hours of the instrument and the blower are shown.

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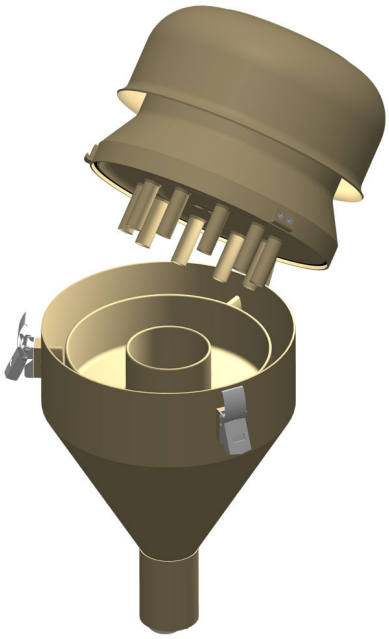
9 Sampling probe PM10 and PM2,5

General information
The sampling probe Digitel DPM10/30 or DPM2.5/30 is designed as a single-stage impactor. The median point Dp50 ("cut point") of the probe separation plot is of an aerodynamic particle of 10 µm or 2.5 µm diameter. A flow rate of 500 l/min. (30 cubic metres per hour) is achieved.
In order to keep the probe weight low, it is made of aluminium. All surfaces are treated with a proven finishing process "Ematal". Ematal surfaces have shown no variation effects on the dust substances subject to analysis so far.
The impactor plate can be taken out of the sampling probe when cleaning of the sampling probe is required. To avoid surface icing of the baffler at low temperatures, the sampling head can be heated (thereby the high-volume sampler Digitel DH77 should be equipped with an option "Special heating").

The PM10 air inlet tube fulfils the conditions of equivalence of the EN directive 12341.

Figure 1: DPM10/30/00



9.1 Separation performance

DPM 10/30/xx

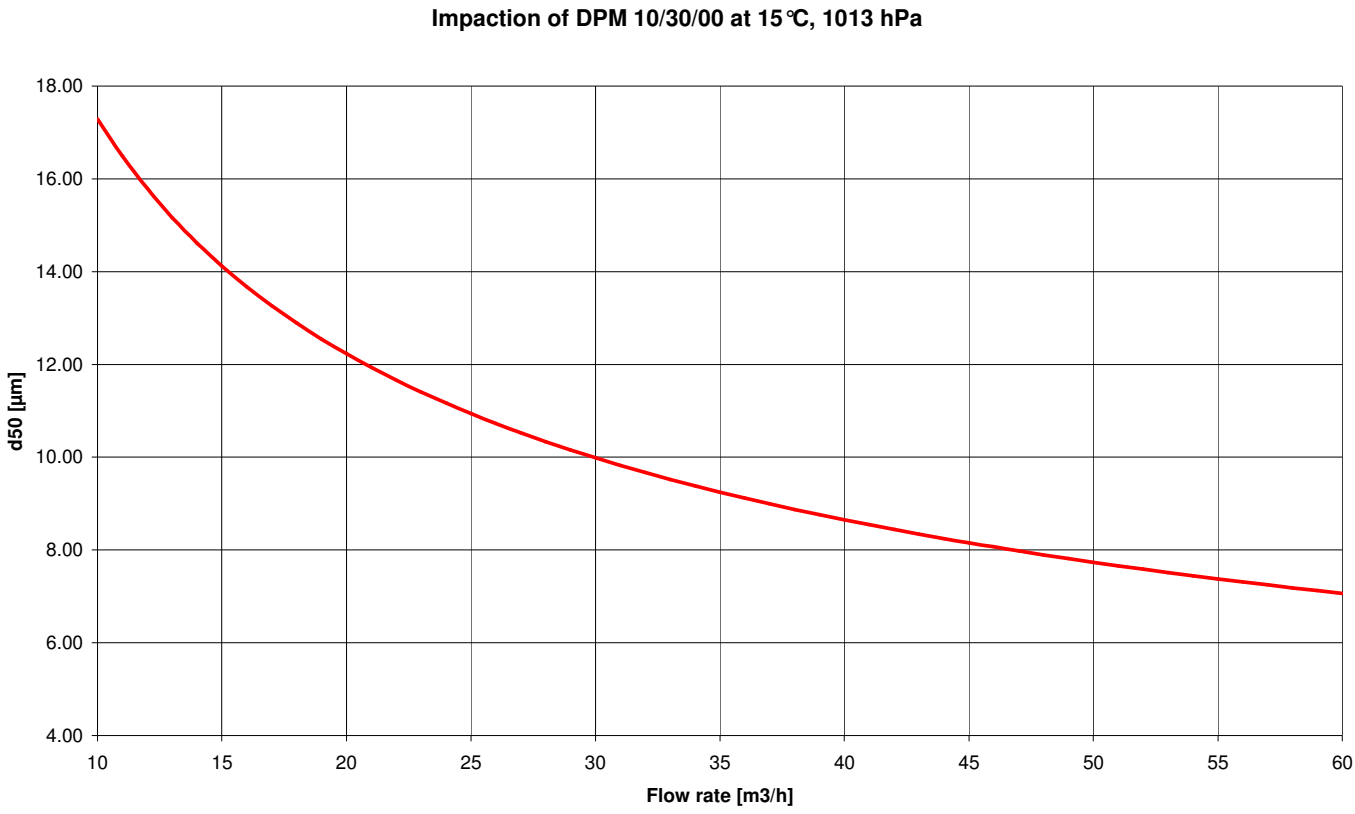


Figure 2: DPM10/30/00 impaction performance

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DPM 2,5/30/xx

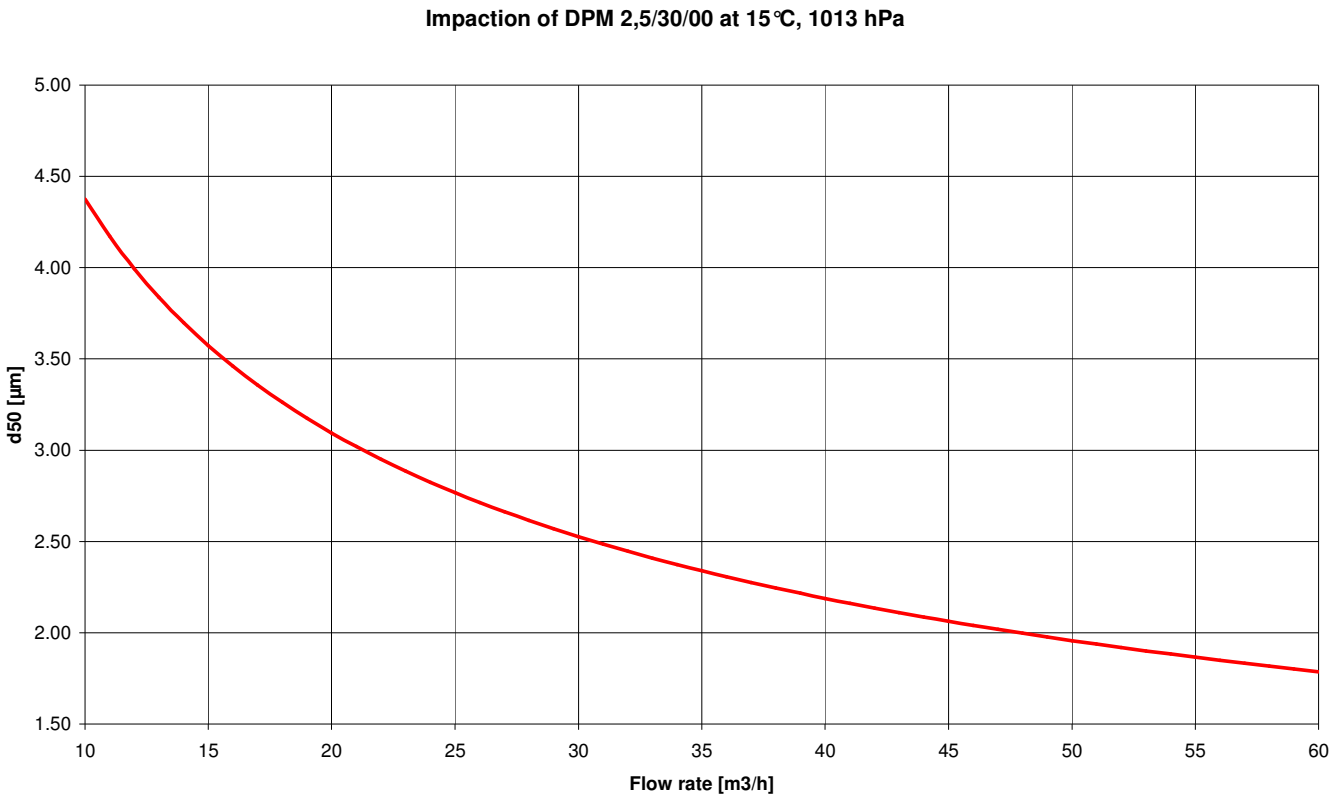

Figure 3: DPM2.5/30/00 impaction performance

9.2 Operation/maintenance

To avoid the release effects of separated rough particles the baffler of the impactor plate has to be permanently covered with a thin grease layer. It has to be renewed periodically. The cleaning period depends on the proportion of rough dust in the ambient air sampled.
It is recommended to clean the impactor plate every 14 sampling days, when the average total dust contents (TSP) at the installation site is approx. 70 to 80 µg/m³. With a lower TSP, the cleaning interval may be longer. An option to extend the cleaning interval results from the moveable impactor plate fitted on the heater holder by rotation of approx. 15° (about 2 cm). The acceleration nozzles point at the still "clean" areas between circularly deposited rough dust layers of the previous sampling operation.

The impactor plate can be simply removed by opening the probe upper part. It has to be cleaned, using a clean cloth, and the baffler area has to be greased regularly. About a 5 cm long band of grease should be equally spread on the area, using a spatula. To facilitate this maintenance, the impactor plate can be replaced by a substitute plate prepared in the laboratory.
The acceleration nozzles, the liners of the probe casing, as well as a liner behind the impactor plate have to be cleaned under above-mentioned TSP conditions, after 30 sampling days.
At a time of longer sampling in foggy environment, it is advised to check the impactor plate for water condensation.

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10 Failures/troubleshooting

10.1 Volume flow functional circuit

10.1.1 Blower does not run up after switching the sampler on.

Possible causes:
1. Failure power electronics:
When reaching the range end, the failure indication status "Blower overloaded" is displayed.
Cause:
Failure in the power electronics (frequency convertor) and/or the blower. Control electronics is operational.
Failure elimination:
Remove the compartment cover of the suction unit/frequency convertor.

a) Check whether protection logics of the frequency convertor has responded. The corresponding failure indication message appears on display of the frequency convertor.With blowers of a negligible running time (1 to 2 years), after resetting the frequency convertor, there can be immediately tried a new sampler start-up using the main switch of the instrument. Mind keeping the lower compartment still open. Upon running up, check the blower for suspect noise generation, while the display of the frequency convertor has to show the output voltage frequency (210 Hz as a maximum).
b) With older blowers (more than 2 years), first check the blower carefully before re-starting.
c) If the frequency convertor gets into the failure indication status immediately after trying to switch the sampler on and this occurs also with the hooked off blower, the frequency convertor is defective. This unit should be sent to the factory to get repaired (resp. replaced).

2. Possible operating error:
- Time program is not in the "Work" status.
- blower is switched off manually
- Sampler is in "Remote control" mode.
- filter changer is not in sampling position

3. Heavy contamination:
The flow meter glass measurement tube is heavily contaminated, e.g. after the sampler ran in a heavily exposed environment without an inserted round filter for a longer time. Please remove and clean the glass measurement tube.

4. Control system
a) The printed circuit board (PCB) "flow control" is defective (replace the board).
b)The infrared photo-sensors configuration on the flow meter is defective (call the service).

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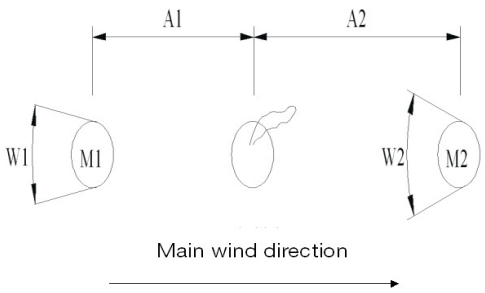
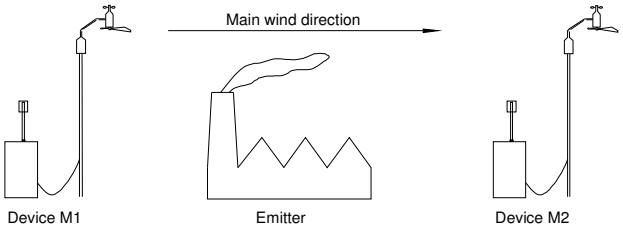
11 Application examples

11.1 Wind-controlled sampling

Wind-controlled sampling for the determination of dust substances, using the Digitel DH77.
With usual imission monitoring, measurement data are determined area wide in relation to the installation site. These measurement data are evaluated in relation to the conceptional formulation (immediate values related to the installation site, hourly, daily and yearly average values etc.). An additional allocation of the recorded data and a potential source is not possible in the majority of cases. Upon special conceptional formulation authorities frequently put particular demands upon imission measurement in order to allow accurate statements on the measured dust compounds origin. This could only be achieved with a very dense and stable measurement network.
Via wind-controlled sampling, using two Digitel High Volume Samplers which are installed in ambit of a special polluter on local conditions, it is also possible to take the weather conditions in consideration. So it is easier to meet requirements that force the probe to be representative of the total lot. (Accreditation Law)
Herewith a considerable improvement of statement and reproducibility is achieved for the recorded data.
Moreover, this measurement method also allows precise prediction of imission burden on installation sites where no measurements are carried out. In addition to that, separate measurement values can be dedicated to a certain polluter.
Using the described measurement arrangement, the following requirements are met:
- independent installation from the emission source;
- only air from the required direction is sampled;
- logging of measurement cycles;
- more exact, more specific and more sensitive statements on samples.

Additional considerable benefits of wind-controlled imission monitoring:
- considerable less filter material has to be evaluated;
- minimum capacity for installation and instruments;
- simple and reliable handling;
- price-friendly upon acquisition and operation.





As illustrated above, aerosol samplers have been installed along with meters for wind velocity and wind direction.
The control takes the data into account transmitted by the wind meter. The air is only sampled if wind arrives at a certain rate from a pre-set direction.

The instrument M1 is installed in the main wind direction before the polluter. The north of the wind meter is directed towards the polluter. The instrument M2 is installed in the main wind direction downstream the polluter. The north of the wind meter points away from the polluter. The appropriate distances A1 and A2 to the polluter determine opening angles W1 and W2.
The complexity for installation of wind-controlled aerosol samplers is limited, as the wind-metering instrument is plugged directly to the Digitel High Volume Sampler. The aerosol sampler supplies control and heating power required by the wind meter and is internally equipped with an arrester. For this just one power connection required.
The dust microprocessor control of the sampler processes data transmitted by the wind meter and controls correspondingly to the blower parameter.
The required opening angle for the wind direction may be within 10° and 160°, the limit for the wind velocity response can be set in 0.5 m/s steps within the range of 0.5 m/s and 5 m/s.
Additionally, the period of time to the average out the measured wind direction and velocity can be set in two minutes steps from 2 minutes up to 32 minutes.
The averaged data of the wind-direction and wind-velocity are performed according to the Austrian standard ÖNORM 9490 part 2.
The reached status and failure indication messages are logged in an integrated printer and in an additional serial interface (RS232C).

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12 Communication

12.1 D-Sub-9 Pin allocation (terminal interface)

Pin allocation:

Pin No.	Signal
2	Receive Data (RxD)
3	Transmit Data (TxD)
5	Ground (GND)
7	Request to send (RTS)
8	Clear to send (CTS)
9	+12V (Res.)

To connect the Digitel HVS with a PC (9-pole connector D-Sub), a "crossed" cable (zero modem) is required.

12.2 Digitel protocol

12.2.1 List of control commands

Control command	Designation
hvs-rmton	Remote control on (this command is valid, only if remote control is off)
Hvs-rmtoff	Remote control off (this command is valid, only if remote control is on)
hvs-status	Status inquiry; status response is permanently transmitted, independently of whether remote control is on or off
hvs-work	Changer in the "Work" operation status; this command is valid, only if remote control is on
hvs-wait	Changer in the "Wait" operation status; this command is valid, only if remote control is on
hvs-pause	Changer in the "Pause" operation status; this command is valid, only if remote control is on
hvs-einst	Output current settings of the instrument

12.2.2 Interface format

Format: 1 startbit, 8 databits, 1 stopbit, no parity
Baud rate: 2 400
Handshake: RTS, CTS

12.2.3 Control commands description

Remote control
The first character of the control command is always a start character (#). The following command has to end up with a control character CR and LF (Carriage return and Line feed).
Response of HVS always starts with a start character (!) followed by a response and final CR, LF.
When HVS receives an unknown command, it responds with HVS-NACK!
The control characters can be written as capital or small letters.

Host:

# (start character)	control character 1	control character 2		
...	control character N - 1	control character N	CR	LF

Response by HVS:

Response character 1	Response character 2	...

Response character N - 1	Response character N	CR	LF

HVS-RMTON
Host:
```
#HVS-RMTON
```

The command switches the HVS into remote control mode. In this mode, the control status of the HVS can be controlled by the host.
Response from HVS:
```
EXTERN
```

HVS-RMTOFF
Host:
```
#HVS-RMTOFF
```

The command switches the HVS to the normal operation mode.
Response from HVS:
```
INTERN
```

HVS-STATUS
Host:
```
#HVS-STATUS
```

The command causes the HVS a transmission of a status message.
Response from HVS (depending on operation status):

```
Status:
Th 14.05.09       14:23:54
Work
Blower on
Motor load: 67%

Collecttime[min]:   126,43
# Blower on/off :     1
paM       [mbar]:   929
TaM         [°C]:    20,0
cM                :     1,053
cs( 15/1013)      :     0,949
cA( 17/ 996)      :     0,972
VM          [m³]:   539,268
Vs( 15/1013)[m³]:   492,990
VA( 17/ 996)[m³]:   497,842
at 512 l/min
---------------------------
```

Moreover, failure messages are additionally transmitted, if so.
The range of the transmitted status information corresponds to the one specified on the printer for output.
It should be noted that each line has to end up with CR, LF. The length of the response string is not defined!

HVS-WORK
Host:
```
#HVS-WORK
```

The command brings the HVS to the "Work" operation status. If the HVS was previously in the "Pause" operation status, the filter exchange is triggered automatically!
The range of transmitted response corresponds to the one specified in the printer for output.
"Response" from HVS:

```
Sa 09.05.09       12:00:12
WORK, ext
```

HVS-WAIT
Host:
```
#HVS-WAIT
```


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The command brings the HVS to "Wait" operation status.
The range of the transmitted response corresponds to the one specified in the printer for output.
Response from HVS:

```
Sa 09.05.09        12:00:12
WAIT, ext
```

HVS-PAUSE
Host:
`#HVS-PAUSE`

The command brings HVS to the "Pause" operation status.
The range of transmitted response corresponds to the one specified in the printer for output.
Response from HVS:

```
Sa 09.05.09        12:00:12
PAUSE, ext
```

HVS-EINST
Host:
`#HVS-EINST`

The command causes the HVS to transmit current settings.
Response from HVS:
Current settings are transmitted to the terminal interface instead of to the printer.

We 13.05.09	11:42:17
version:	HW1.12
Repeat after 2h	off
Stop time at pwr. fail	off
send failure msg. only	off
blower capacity	on
blower cap. >=90%	off
Blower pwr. sens.[%] :	2
# Blower on/off	on
Bayern-Hessen-Prot.	on
Bayern-Hessen-Prot. B	on
Bayern-Hessen-Address:	310
curr. blower capacity	on
curr. collecttime	on
Press. meas.	on
Temp. meas.	on
Press. Amb.	on
Temp. Amb.	on
act. corr. meas.	on
act. corr. stand.	on
act. corr. amb.	on
collecttime	on
p avg.	on
temp. avg.	on
p avg. amb.	on
T avg. amb.	on
avg. cM/VM	on
avg. cs/Vs	on
avg. cA/VA	on
repeated printout	on
printer	on
short messages	off
Press./Temp. Corr.	On
cs	On
cm	On
ca	On
vs[m³]	on
vm	On
va	On
tvg. press./temp.	on
temp. stand. [°C]	8
press. stand.[mbar]	1013
press. (ref)[mbar]	995
Press. meas. [mbar]	993
temp. meas. [°C]:	22,8
flow through [l/min]	500
Wind meas.	off

12.3 Bayern-Hessen protocol

Interface format
Format: 1 start bit, 8 data bits, 1 stop bit, no parity
Baud rate: 1 200 (2 400 Baud in the Bayern-Hessen protocol B version)
Handshake: semi duplex operation, polling method
Checksum: (Block Check Character) XOR of all characters inclusive STX and ETX with start value 0

Bayern-Hessen protocol Subset for Digitel HVS
Data inquiry structure

Field No.	Start position	End position	Content	Description
1	0	0	<STX>	Start of Text
2	1	2	DA	
3	3	3	<ETX>	End of Text
4	4	4	<BCC1>	High-Nibble BCC
4	5	5	<BCC2>	Low-Nibble BCC

Data transmission structure

Field No.	Start position	End position	Content	Description
1	0	0	<STX>	Start of Text
2	1	2	MD	Protocol ID
3	3	5	nn<>	Number of measurement instruments (01)
4	6	9	nnn<>	Measurement instrument ID
5	10	18	±nnnn±ee<>	Measurement value (blower load)
6	19	21	hh<>	Operation status
7	22	24	hh<>	Failure indication status
8	25	35	hhh<>hhhhh<>	Serial No. of measurement instrument (000 000000)
9	36	36	<ETX>	End of Text
10	37	37	<BCC1>	High-Nibble BCC
11	38	38	<BCC2>	Low-Nibble BCC

Operation status in Bayern-Hessen protocol (1 200 Baud):
Bit 0: Remote control on
Bit 1: Maintenance
Bit 2: End of program
Bit 3: ---
Bit 4: Blower off
Bit 5: Work
Bit 6: Pause
Bit 7: Filter exchange

Failure indication status:
Bit 0: Changer jammed
Bit 1: Overload
Bit 2: Magazine empty

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If more than one measurement value is transmitted, the fields 4 to 8 are repeated as frequently as the number of measurement values is defined.
Warning: The first three characters of the instrument ID are transmitted in the Bayern-Hessen protocol in the block "Seriennummer" (serial No.). If the Bayern-Hessen protocol is applied, the first three characters have to be either numerical resp.blank characters.

Bay. Hessen control telegram for Digitel HVS

Control command structure

Field No.	Start position	End position	Content	Description
1	0	0	<STX>	Start of Text
2	1	2	ST	
3	3	5	310	Instrument address
4	6	6	x	Control command
5	7	7	<ETX>	End of Text
6	8	8	<BCC1>	High-Nibble BCC
7	9	9	<BCC2>	Low-Nibble BCC

Control command:
"E" Remote control on
"W" Wait
"B" Work
"P" Pause
"F" Filter exchange
"A" Remote control off
"C" initialisation of cM, cA, cs, VM, Vs, VA sampling time, filter-change flag; in the Bayern-Hessen protocol modes 3 and 4, the sampling time cM, cA, cs, VM, Vs, VA and filter-change flag values are transmitted until the control command "C" is received. Herewith it is ensured that the receiver receives the data.

12.4 AK-Protocol

Implemented control commands

Control command	Description
AREG	Ask Register Command – actually implemented
EREG	Enter Register Command – actually not implemented
SFxx	Set Function xx Command – actually not implemented
ASTO	Ask Storage Command – actually not implemented
SSTO	Set Storage Command – actually not implemented

Interface format
Format: 1 start bit, 8 data bits, 1 stop bit, no parity
Baud rate: 2400
Handshake: ---

Control command structure
General transmission format
The first character of a command is always a start character (STX). After that the next digits/figures will follow: station number (ASCII), "AREG", a blank, a two-digit channel number (ASCII), a blank, a one-3- digit program register code (ASCII). The string is closed by a final character (ETX).
The answer of the HVS has following format: the first character is always a start-character (STX). After that the next digits/figures are as follows: station number (ASCII), "AREG", a blank, a digit status (ASCII), a blank, a one 3-digit program register code (ASCII); length is not defined! The string is closed by a final character (ETX). Up to three figures could follow. The HVS sends a "CR" and "LF".
ATTENTION: Station number for HVS: "4"
Channel number for HVS: "K0"

Request:

STX	4	A	R	E	G		K	0		PRC	PRC	ETX

Respond:

STX	4	A	R	E	G		0		PRC	PRC
	Data			ETX		CR	LF			

Respond data format:
actual blower load: 000-100 till 3 digits [%]
act. Temp., avg. Temp. in measurement system: ±25,3 till 5 digits [°C]
act. pressure, avg. pressure in measurement system: 1006 till 4 digits [mbar]
Elapsed collecttime for the actual filter, Elapsed collecttime for the last completed filter: 12317,17 till 8 digits [minutes]
cM, cs, cA: 00001,034 till 9 digits
VM, Vs, VA: 12067,345 till 9 digits [m³]

Description of Program Register Code:

PRC	Description
0	Actual blower load[1]
1	Actual temperature conditions in measurement system[1]
2	Actual pressure conditions in measurement system[1]
3	Elapsed collecttime of the actual filter[1]
4	act. cM[1]
5	act. cs[1]
6	act. VM[1]
7	act. Vs[1]
10	Operation status [2]
11	Failure indication status [3]
20	Elapsed collecttime of the last completed filter[4]
21	Average temperature conditions in measurement system during sampling periode[4]
22	Average pressure conditions in measurement system during sampling periode[4]
23	cM of the last completed filter[4]
24	cs of the last completed filter[4]
25	VM of the last completed filter[4]
26	Vs of the last completed filter[4]
30	act. cA[1]
31	act. VA[1]
40	Average temperature conditions on the air inlet of the last completed filter during the sampling period (this is an estimated condition: flow-meter average temperature - 3K).
41	Average pressure conditions on the air inlet of the last completed filter during the sampling period (air pressure average value before and after sampling on the sampling head) [4]
42	cA of the last completed filter[4]
43	VA of the last completed filter[4]

[1] Values for PRC: 0 till 2 are actual values. It averages that this are the last measured values.
Values for PRC: 3 till 7, 30, 31 are actually computed values.
1 Operation status:

State	Description
xxx0	Work
xxx1	Wait
xxx2	Pause
xx0x	Blower off
xx1x	Blower on

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x0xx	No filter change
x1xx	Filter changed
0xxx	Remote off
1xxx	Remote on

2 Failure indication status:

State	Description
xx0	Changer OK
xx1	Changer jammed
x0x	No blower overload
x1x	Blower overload
0xx	Filter magazine filled
1xx	Filter magazine empty

3 Values for PRC: 20 till 26, 40 till 43 are values for the last completed filter.

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13 Data recording with USB-drive

Filter data, status messages and wind data are stored in the internal flash module of the control. Filter data, status messages or failure messages are stored in the log file. The wind data in the wind file. Up to 10,000 entries are recorded per file.

13.1 Storing of data on the USB-drive

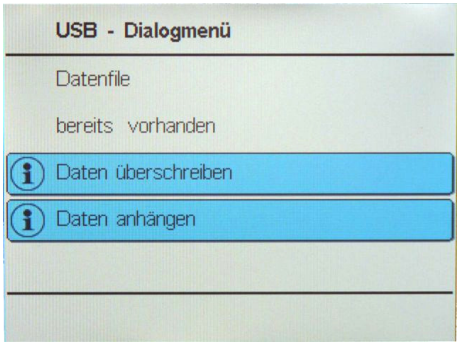
With the plugged-in USB drive the recorded data are stored simultaneously on the internal memory as well as on the USB drive. That is the reason why the USB drive can be removed any time. (Attention: please consider the mode removal USB ! See 13.2 Removal USB drive)

After the removal of the USB-drive the control only stores the data records on the internal memory. By plugging-in the USB-drive anew the user is asked if all the recorded data should be stored on the USB-drive since this one has been unplugged.

save existing data: all data, since the last removal of the USB-drive, will be copied on the USB drive.
Subsequently all data coming in after that, will be stored on the USB-drive.

Save new data only: only all new data coming in after the plugging-in will be stored on the USB-drive

If there is already a file with the same name, a menu appears:

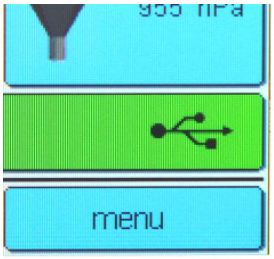


Overwrite data: the new file is written over the old file

Attach data: the new data is attached to the existing file

13.2 Removal of USB-drive

The USB-drive can be removed any time by compliance with following instructions.
To get into the program "Mode removal USB" on the display the basic menu has to be visual.



If the USB-Logo is chosen, the display changes to USB dialogue:

Now the USB-drive can be removed without data loss. After the removal of the USB drive for a few seconds the message "USB drive removed" appears.

13.3 Structure of the data files on the USB-drive

13.3.1 File name

The storage of the recorded data will be affected in following files. The file names exist of 2 parts. The first two figures indicate the type of data:

DL... Digitel Log file
Filter data, cartridge data and status messages

DW... Digitel wind file
Wind data

The second part of the data files is variable. This part has been either composed of an instrument ID- number or a fix DMCU-unicum number.
The instrument ID-number can be set up in the menu "Special settings" (see xxx).

If the instrument ID-number has been activated, the first five figures will be fitted into the file name:

Example instrument ID- number on:

Instrument ID-number = TESTABCD"

Log file - file name = DL_TESTA.dat

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Wind file – file name = DW_TESTA.dat

If the instrument ID-number is switched off, the last six figures of the unicum number are fitted into the file name:

Example instrument ID-number off:

DMCU – unicum number = 0000001B3298

Log file – file name = DL1B3298.dat
Wind file – file name = DW1B3298.dat

13.3.1.1 Log file DL_xxxxx.DAT

The data in the file DL_xxxxx.DAT are saved in a table. As separators between the columns, the Tab character (HT, 09H) is applied. The line break is activated using CR, LF.
For example, after formatting on the HVS, the file looks as follows:

Event	Date/ time	Sampling time (min.)	paM [mbar]	TaM [°C]
pA [mbar]	TA estimated [°C]	cM	cs (15°C / 1013 mbar)	cA
VM (512 l/min) [m³]	Vs (15°C / 1013 mbar); (512 l/min) [m³]	VA (512 l/min) [m³]		

Column:	Description
Event	status information (Blower on, Work etc.)
Date/time	year, month, day, hour, minute, second
Collecttime	inserted filter sampling time in minutes
paM	average air pressure during sampling time in mbar at measurement tube
TaM	average air temperature during sampling time in °C at measurement tube
pA	average value before and after sampling of air pressure in hPa at inlet
TA	average air temperature during sampling time in °C at inlet
CM	flow rate correction factor on the measurement tube for average pressure and temperature conditions during the sampling time
cs (15°C/1013 mbar)	flow rate correction factor related to entered standard conditions
cA	air flow correction factor on inlet
VM	transported air volume in cubic metres (related to determined measurement values on the measurement tube)
Vs (15°C/1013 mbar)	air volume that would have been transported in standard conditions; temperature (15°C) and pressure (1 013 mbar) depends on setting "standard temperature" and "standard pressure" during the formatting procedure.
VA	air volume to be transported during the sampling time through an inlet

13.3.1.2 Wind file DW_xxxxx.DAT

The data file DW_xxxxx.DAT is set only when wind measurement is activated. Data in the file DW_xxxxx.DAT are saved in a table. As separators between the columns, the Tab character (HT, 09H) is applied. The line break is activated with the use of CR, LF. After formatting on HVS, the file looks as follows:

Date/time	Wind direction (grade)	Wind velocity (m/s)	Blast (m/s)

Column	description
Date/time	Year, month, day, hour, minute, second
Wind direction	Average wind direction
Wind velocity (m/s)	Average wind velocity
Blast (m/s)	Maximum wind velocity during time of averaging

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13.3.2 Remote control via HTTP

13.3.2.1 Status request

You can update the contents of the website by clicking on the pushbutton "Status".

13.3.2.2 Activate remote control

You can activate the remote control by clicking on the pushbutton "remote control". The program status first changes if you transmit more commands.

13.3.2.3 Status change

If the remote control is active, you can change the program status by clicking on the appropriate pushbutton..

Work ... the program changes into the work - status. At the change from the Pause status into a filter change takes place..

Wait ... The program changes into the Wait - status. At the status "Wait" the blower is turned off and a sampling will not be executed. A change into the status "Work" takes place without a filter change.

Pause ... the program changes into the Pause - status. If you change from Pause into another status, a filter change always takes place. If the magazine is empty, there can't be activated any other status than Pause!

Filter change ... You can execute a filter change any time if the magazine is filled.

13.3.2.4 Turn off remote control

If you turn off the remote control, the control system changes into the status before the activating of the remote control.

14 Remote DH77 via the Internet

The control system of the High Volume sampler DH77 includes a FTP - and a HTTP- server.

For the status check the FTP - server provides a status-, error- and data-file.

Via the HTTP- server an easy remote control and a status request of the High Volume sampler are possible.

14.1 FTP-server

14.1.1 Dial-up

The internet connection can only be effected by means of a user name and password.

User name (Default):DIGITEL
Password (Default):default

These default-values are set up factory-made.

Attention:

Before transmission of the control system file please set IP-address (see 8.2.2.3.2 Ethernet and 8.2.2.2.4 Change instrument ID).

14.1.2 Breaking off connection

The FTP – client can break off the connection and start a new one any time.

14.1.3 Contents of the FTP - server index

14.1.3.1 Status - file "status.dat"

The status-file contains information concerning program status, current blower capacity, current pressure and temperature.

14.1.3.2 Failure indications - "err_file.log"

The failure indication -file contains occurred faults such as overload, power breakdowns or blocked cartridge changer.

Example:

```
power cut from:
Mo 14.02.09 14:09:20
until:
Mo 14.02.09 14:09:23

Mo 14.02.09 14:15:26       Work
```

The contents of the err_file.log - files can be deleted by means of transmission of the file "del_err.txt" with contents "delete".

14.1.3.3 Protocol - file - "hvsdat.dat"

The protocol - file contains all filter data, status messages, settings which were set up for the logging.

Example:

```
We 13.05.09        10:47:25
device id:
DEVICE 1
filter data:
col.-time[min]:          0,02
pmM         [hPa]:   942
TmM          [°C]:    24,6
kM( 25/ 942)     :     1,054
ks( 15/1013)     :     0,948
ka( 22/ 940)     :     1,046
VM( 25/ 942)[l] :      0,879
Vs( 15/1013)[l] :      0,790
Va( 22/ 940)[l] :      0,871
at Q Scale i.: 500,00 l/min


We 13.05.09        10:47:25
Work
```

The contents of the hvsdat.dat – file can be deleted by means of transmission of the file "del_dat.txt" with contents "delete".

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14.2 HTTP - Server

The HTTP - server issues a website with all current measuring values and enables via pushbuttons an easy remote control of the High Volume sampler.

14.2.1 Dial-up

The internet communication can only be established by a user name and a password.

User name: (Default):root
Password (Default):password

14.2.2 Remote control via HTTP

14.2.2.1 Status request

You can update the contents of the website by clicking on the pushbutton "Status".

14.2.2.2 Activate remote control

You can activate the remote control by clicking on the pushbutton "remote control". The program status first changes if you transmit more commands.

14.2.2.3 Status change

If the remote control is active, you can change the program status by clicking on the appropriate pushbutton..

Work ... the program changes into the work - status. At the change from the Pause status into a filter change takes place..

Wait ... The program changes into the Wait - status. At the status "Wait" the blower is turned off and a sampling will not be executed. A change into the status "Work" takes place without a filter change.

Pause ... the program changes into the Pause - status. If you change from Pause into another status, a filter change always takes place. If the magazine is empty, there can't be activated any other status than Pause!

Filter change ... You can execute a filter change any time if the magazine is filled.

14.2.2.4 Turn off remote control

If you turn off the remote control, the control system changes into the status before the activating of the remote control.

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15 Flow meter tables

15.1 Calibration table

Metric Grösse 47 für 100-1000 l/min.Luft bei 15°C - 1013 mbar mit Aluminiumschwimmer											
Metric size 47 for 100-1000 l/min. air at 15°C - 1013 mbar with aluminum floater											
Metric grandeur 47 pour 100-1000 l/min.air à 15°C - 1013 mbar avec flotteur en aluminium											
Flow rates (l/min. air at 15/760) against distance for 2000 series, size 47 tube, Dural free float (2000/47/410/AFG)											
Distance	**Flow rate**	**Distance**	**Flow rate**	**Distance**	**Flow rate**	**Distance**	**Flow rate**	**Distance**	**Flow rate**	**Distance**	**Flow rate**
mm	l/min	mm	l/min	mm	l/min.	mm	l/min.	mm	l/min.	mm	l/min.
0	92.00	45	228.07	90	368.41	135	519.58	180	684.40	225	864.09
1	95.06	46	231.10	91	371.64	136	523.12	181	688.27	226	868.12
2	98.12	47	234.13	92	374.89	137	526.65	182	692.15	227	872.15
3	101.18	48	237.16	93	378.13	138	530.20	183	696.03	228	876.19
4	104.23	49	240.19	94	381.38	139	533.75	184	699.93	229	880.23
5	107.28	50	243.23	95	384.64	140	537.31	185	703.83	230	884.27
6	110.32	51	246.27	96	387.90	141	540.87	186	707.74	231	888.32
7	113.37	52	249.31	97	391.16	142	544.44	187	711.65	232	892.37
8	116.41	53	252.35	98	394.43	143	548.01	188	715.58	233	896.42
9	119.45	54	255.40	99	397.71	144	551.59	189	719.51	234	900.48
10	122.48	55	258.45	100	400.98	145	555.18	190	723.45	235	904.54
11	125.51	56	261.50	101	404.25	146	558.77	191	727.39	236	908.61
12	128.54	57	264.56	102	407.53	147	562.37	192	731.34	237	912.69
13	131.57	58	267.62	103	410.81	148	565.97	193	735.30	238	916.77
14	134.60	59	270.69	104	414.09	149	569.58	194	739.27	239	920.86
15	137.62	60	273.75	105	417.39	150	573.19	195	743.24	240	924.95
16	140.64	61	276.83	106	420.68	151	576.79	196	747.21	241	929.05
17	143.66	62	279.90	107	423.99	152	580.39	197	751.19	242	933.15
18	146.68	63	282.98	108	427.30	153	583.99	198	755.17	243	937.27
19	149.70	64	286.07	109	430.61	154	587.59	199	759.16	244	941.39
20	152.72	65	289.15	110	433.93	155	591.20	200	763.14	245	945.52
21	155.73	66	292.25	111	437.26	156	594.82	201	767.14	246	949.65
22	158.75	67	295.34	112	440.60	157	598.44	202	771.14	247	953.80
23	161.76	68	298.45	113	443.94	158	602.07	203	775.14	248	957.95
24	164.77	69	301.57	114	447.29	159	605.71	204	779.15	249	962.11
25	167.78	70	304.70	115	450.64	160	609.36	205	783.17	250	966.28
26	170.79	71	307.84	116	454.00	161	613.01	206	787.19	251	970.46
27	173.81	72	310.98	117	457.37	162	616.67	207	791.21	252	974.65
28	176.82	73	314.13	118	460.74	163	620.34	208	795.24	253	978.85
29	179.83	74	317.29	119	464.13	164	624.02	209	799.27	254	983.06
30	182.84	75	320.45	120	467.52	165	627.70	210	803.31	255	987.28
31	185.85	76	323.61	121	470.91	166	631.40	211	807.35	256	991.51
32	188.86	77	326.78	122	474.32	167	635.10	212	811.39	257	995.75
33	191.87	78	329.95	123	477.75	168	638.81	213	815.44	258	1000.00
34	194.88	79	333.13	124	481.19	169	642.53	214	819.49	259	1004.26
35	197.89	80	336.31	125	484.65	170	646.26	215	823.55	260	1008.54
36	200.90	81	339.50	126	488.11	171	650.00	216	827.61	261	1012.83
37	203.92	82	342.69	127	491.58	172	653.78	217	831.67	262	1017.13
38	206.93	83	345.89	128	495.05	173	657.58	218	835.74	263	1021.44
39	209.95	84	349.09	129	498.53	174	661.38	219	839.81	264	1025.76
40	212.96	85	352.30	130	502.03	175	665.19	220	843.88	265	1030.10
41	215.98	86	355.51	131	505.52	176	669.02	221	847.96	266	1034.45
42	219.00	87	358.73	132	509.03	177	672.85	222	852.04	267	1038.82
43	222.02	88	361.95	133	512.54	178	676.69	223	856.04	268	1043.20
44	225.05	89	365.18	134	516.06	179	680.54	224	860.06	269	1047.59
										270	1052.00

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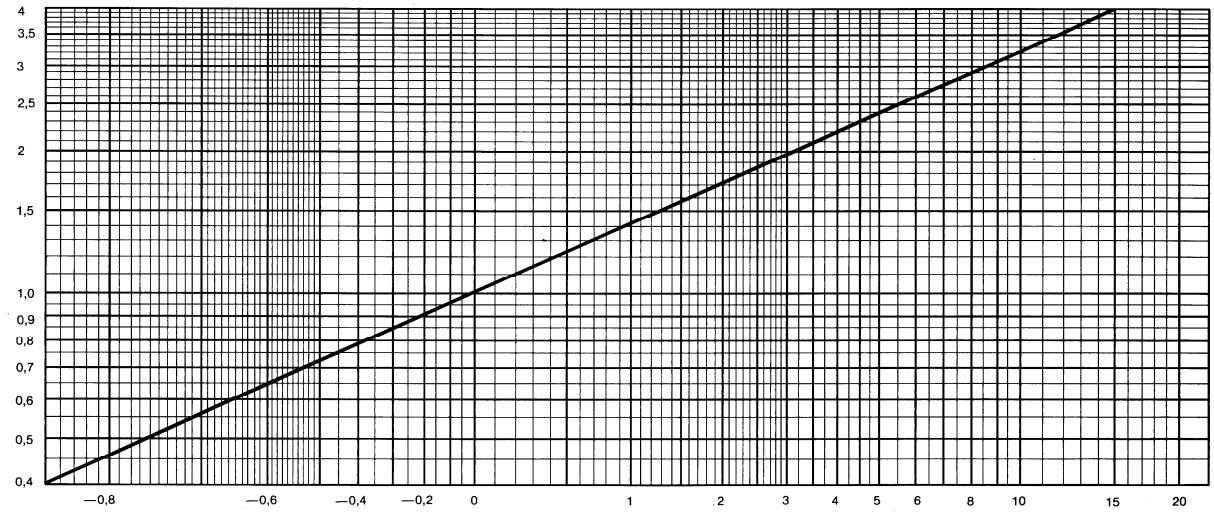
15.2 Pressure / temperature correction table

Pressure correction for gases at turbulent operation	
Calculation of correction factor for measurement instrument applying pressure differing from an original one $c = \sqrt{\frac{1.013 + Ps}{1.013 + Pe}}$ c: correction factor to be multiplied with the reading of the flow meter at calibration pressure Pe and operation pressure Ps	Ps = operation pressure in hPa Pe = calibration pressure in hPa (indicated on the measurement tube)

Correction plot applied, if the measurement instrument is calibrated at 1 013 bar absolute, and now applied for another pressure.

correction factor c

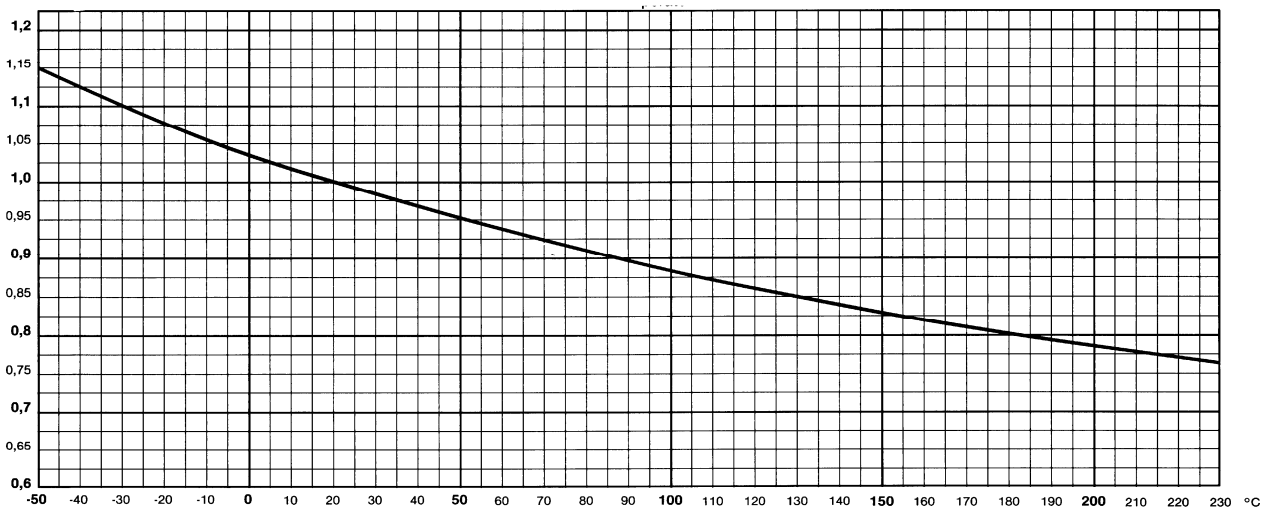


Operation pressure in hPa

Temperature correction for gases at turbulent operation	
Calculation of correction factor for a measurement instrument applying another temperature than the original temperature: $c = \sqrt{\frac{273 + te}{273 + ts}}$ c: correction factor to be multiplied with the showed value of the flow meter at a calibration temperature Te and an operation temperature Ts. If Te = 20 °C, the below plot directly gives the correction factor c	Ts = operation temperature in°C Te = calibration temperature in°C (indicated on the measurement tube)

Correction plot applied, if the measurement instrument is calibrated at 20°C absolute, and now applied for a different value of temperature.

correction factor c



Temperature in °C ts

Figure 4: Pressure and temperature correction table

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16 Technical data

Model	**DH-77**
Type	Field case
Power supply	230 V +6/-10 %; 50 Hz; max. 1700 VA
Fuse	10 A
Connecting cable	3 x 1.0 mm², 10 A, 250 V
Installation	Category II (standard mains)
Application range	5 to 40°C; 10 to 90 % RH or -20 to 40°C; 10 to 95 % RH with interior heating, maximum operation altitude of 2000 m above the sea level*
Flow rate	Standard: 420-600 l/min, max: 100 till 1000 l/min
„Volume flow“ Control accuracy	< 5 % of MBE
Suction unit, average life cycle	36 000 h
Settings reproducible accuracy (according to UMEG report No. 6-08/00)	+- 0.45%
Logged standard and measured volumes Accuracy	<+/- 2%
Time programs	Work, Pause (0 to 59999 minutes each); start time adjustable using date and time
Outer dimensions (H x W x D)	1300, 600, 250 mm
Weight	46 kg
Protection class	IP54
Filters	1 round filters of d = 150 mm (flowing area of d = 140 mm); filter material depends on the aim of analysis
Underpressure at 1,000 l/min.	max. 130 mbar
Manual filter exchange	✔
RS232C remote control	✔
RS232C logging	✔
Overloading switch-off	✔
Operation-hour counter	✔
Motor-load indication	✔
Multi-language logging	✔
Battery-backed data memory	✔
Battery-backed clock module	✔ (+/- 4 second daily
Pre-separator heating	30 V; 50 Hz; 60 VA max.
Pre-separator	TSP, PM10, PM 2.5, PM1 optionally with integrated heating and excess temperature protection
PAH cartridge holder	✔
USB interface	✔
Log printer	✔
Interface protocols	DIGITEL, Bayern-Hessen protocol, customer-specific

* Special execution for operation altitudes above 2000 m upon request

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17 Dimension drawings

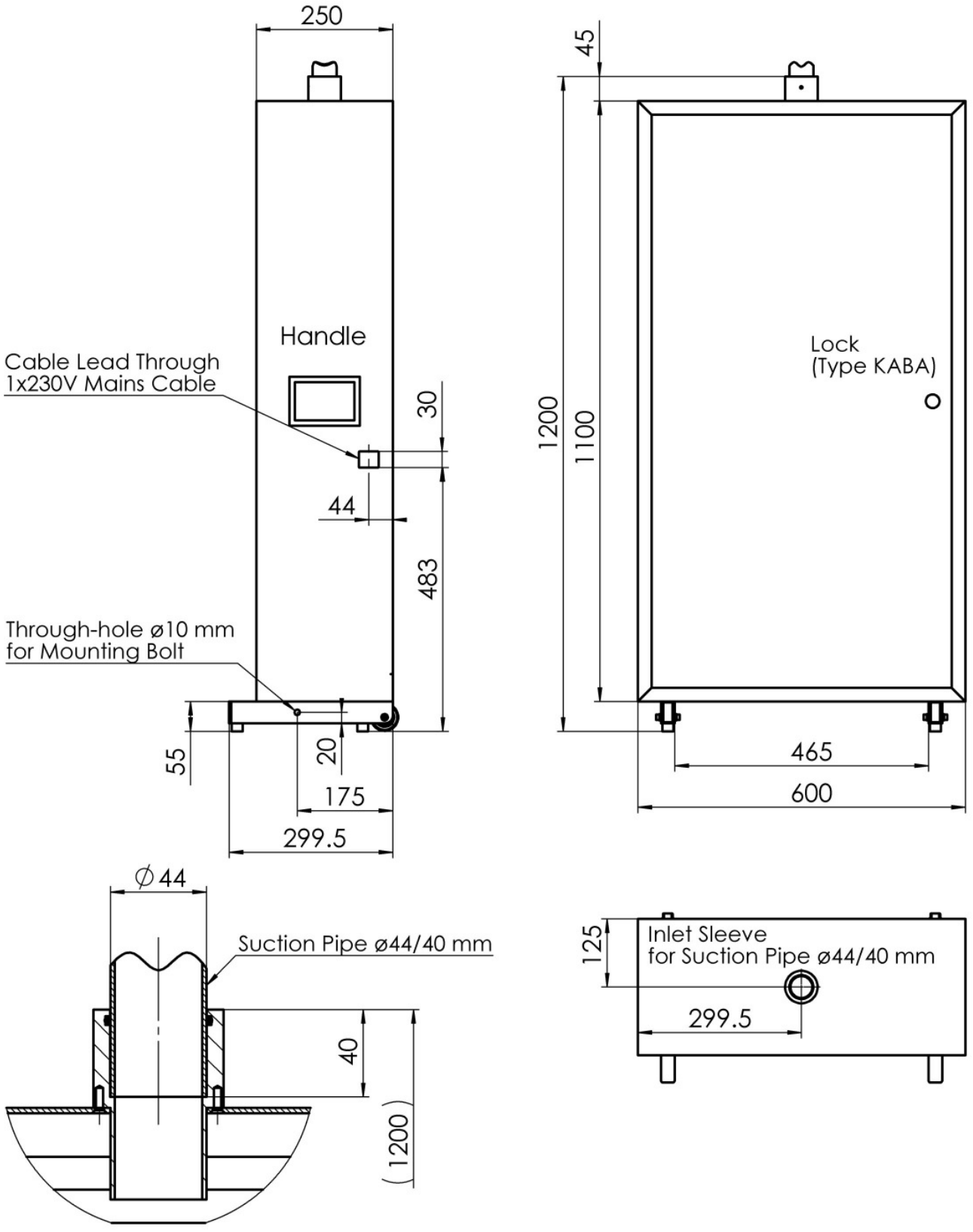

Figure 5: Dimension drawing field housing DH77

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18 EC-Declaration of conformity

in terms of the EC directives

-Machines 89/392/EWG modified by 91/368/EEC and 93/44/EEC, Appendix IIA
-Electromagnetic compatibility 89/336/EEC modified by 93/31/EEC
-Low potential voltage 73/23/EEC

The machine:

Manufacturer: DIGITEL AG, Switzerland
Type: DH77
No.:
Year of manufacture: 2011

has been developed, construed and manufactured in accordance with the above mentioned EC directives, in sole responsibility of

DIGITEL AG, Switzerland and DIGITEL GmbH, Austria

Following tests and test procedures were applied:
-Emitted interference: requirement according to Cenelec EN 61326-1: 1997/A1: 1988
-Test conducted radio emission according to Cenelec EN 55022: 1998 CISPR16-1
-Test electric field strength according to Cenelec EN 55022: 1998 CISPR16-2
-Test overtone currents according to Cenelec EN 61000-3-2: 1995/A1: 1998/A2: 1998
-Test flicker according to Cenelec EN 61000-3-3: 1995
-Interference resistance: requirement according to Cenelec EN 61326-1:1997/A1: 1988
-Test Cenelec EN 61000-4-2: 1995/A1:1998
-Test Cenelec EN 61000-4-3: 1996/A1:1998
-Test Cenelec EN 61000-4-4: 1995
-Test Cenelec EN 61000-4-5: 1995
-Test Cenelec EN 61000-4-6: 1995
-Test Cenelec EN 61000-4-11: 1994

Following reports can be requested from DIGITEL GmbH:

- Inspection report VDI
- Inspection report concerning the development of the noise level
- LAI report
- UMEG inspection report

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